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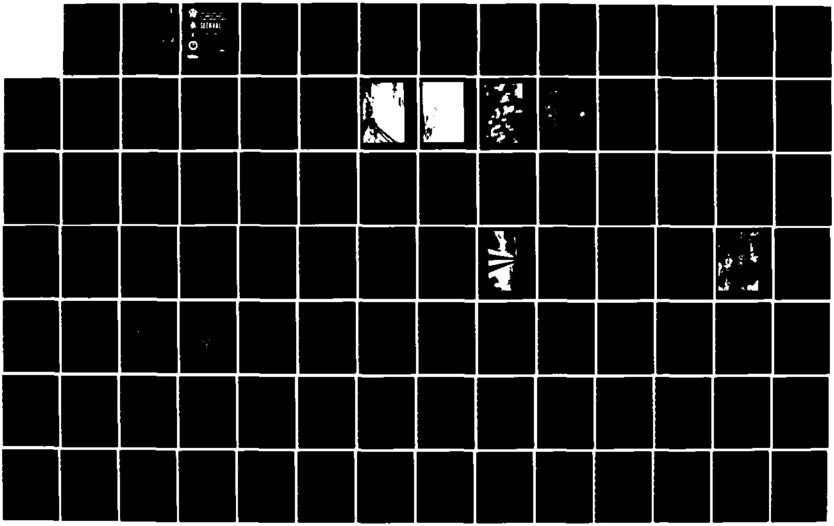

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Joint Test Project Plan

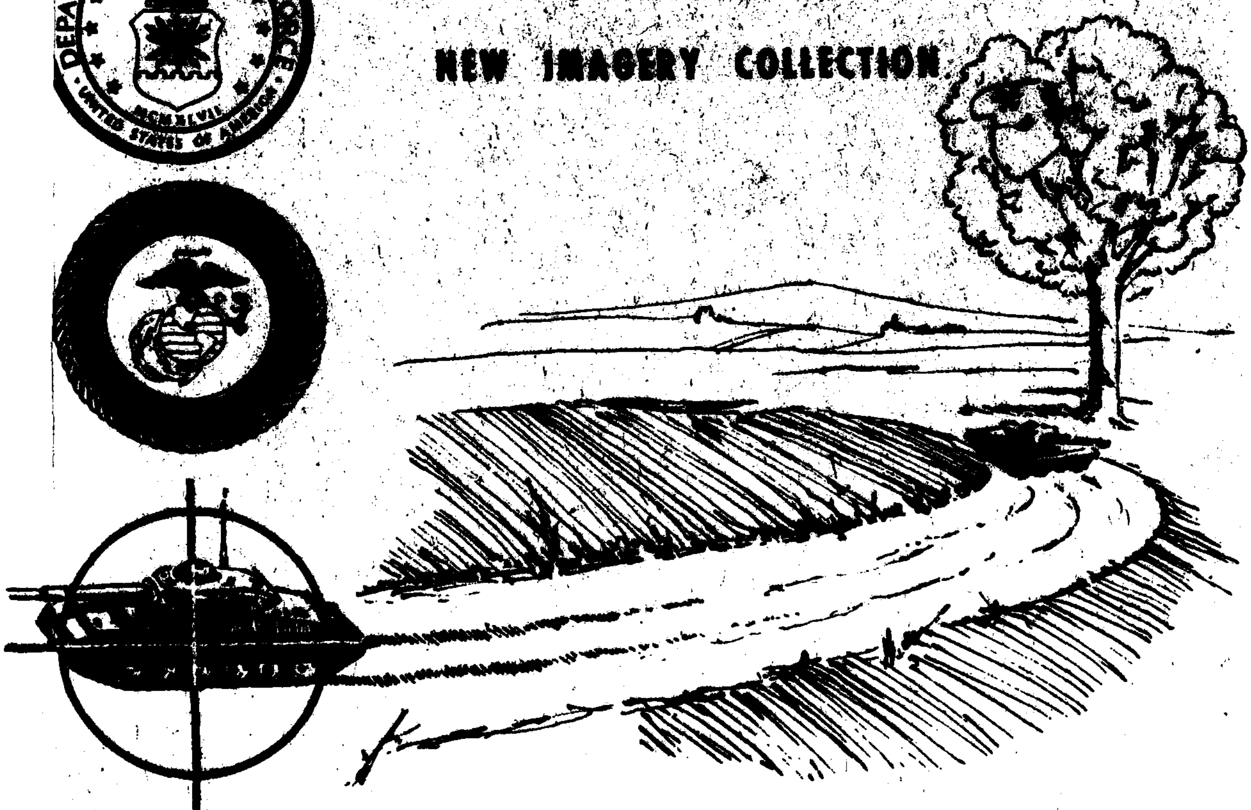
Mar. 74

# of Combat Air Support Target Acquisition Program

SEEKVAL

Project IC1 Report

NEW IMAGERY COLLECTION



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PHASE I

FINAL REPORT
IC1
IMAGERY COLLECTION

MARCH 1974

This final report has been reviewed and approved by:

J. R. Douglas
JACKIE R. DOUGLAS, Colonel, USAF
Joint Test Force Director

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ILLUSTRATIONS

TABLES

ABBREVIATIONS

AGL	Above Ground Level
ASL-MT	Atmospheric Sciences Laboratory - Meteorological Team
BAC	The Boeing Aerospace Company
CORN	Controlled Range Network
EPA	Environmental Protection Agency
FOV	Field of View
fL	foot-Lambert
HLMR	Hunter Liggett Military Reservation
IR	Infrared
M/E	Mission/Encounter
MMS	Multi-mission Simulator
NOE	Nap-of-the-Earth
PM	Project Manager
RPMI	Radiant Power Measurement Instrument
SO	Standard Observation
USACDEC	U. S. Army Combat Development Experimentation Command
UTM	Universal Transverse Mercator

REFERENCES

(a) SEEKVAL Test Directive, Subject: New Imagery Collection, Part I, Project Number IC1, dated July 1973

(b) SEEKVAL Project Plan, Project Number IC1, dated September 1973

(c) Daily Log of CMSgt E. W. Gwathney, USAF, for the period 26 September - 13 October 1973 (NOTAL)

(d) SEEKVAL Ground Truth Data, Mead Technology Laboratory Report dated 12 November 1973

SEEKVAL PROJECT IC1

SEEKVAL IMAGERY COLLECTION PART I

1. INTRODUCTION

a. Background.

(1) The overall project plan for SEEKVAL Phase I, published in July 1973, outlines a series of experiments to be conducted to satisfy the Phase I objectives. One of this series is an experiment to study aided visual acquisition of tactical targets in a wide field-of-view (FOV) multi-mission simulator (MMS) at the Boeing Aerospace Company (BAC) Kent, Washington, facility. Since existing imagery is unsuitable for this purpose, a two-part imagery collection effort will be conducted under the authority of the overall project plan. Project IC1 was the first of the two parts and was conducted to generate data to be used in designing the more comprehensive (Part II) collection effort planned for the spring of 1974 at Fort Riley, Kansas.

(2) SEEKVAL project IC1 was a limited test to define and attempt to resolve the technical, mechanical, logistical, and adminstrative problems involved in the collection of photographic and infrared (IR) imagery.

b. Description of Equipment. The equipment used in this test is listed below. Selection of specific equipment for each type of imagery was based on its availability during the time of the project and its anticipated capability to produce the best image quality of the test terrain.

(1) Aircraft.

(a) A modified B-25G was used as a platform for collection of all fixed-wing imagery. Sensors used were a 70mm motion picture camera, two Maurer 500 reconnaissance cameras (one vertical and one oblique), and an AN/AAS-27 line scan IR system.

(b) An Army UH-1H was used as the platform for rotary-wing pop-up imagery collection (70mm only). The 70mm motion picture camera was mounted on a Tyler 806M flexible camera mount. The complete assembly was located in the aircraft cargo space with the camera FOV out the left cargo door.

(c) An Army AH-1G was used as the platform for rotary-wing nap-of-the-earth (NOE) imagery collection. The 70mm camera was mounted firing forward on a pedestal mount located in the nose battery compartment.

(2) Tyler Model 806M Helicopter Camera Mount. A Tyler 806M camera mount was borrowed from the Air Audio-Visual Service, Norton AFB, CA., for the project. It was used to mount the 70mm camera in the UH-1H helicopter for rotary-wing pop-up imagery collection. The mount is designed to isolate the camera system from airframe vibrations and to provide a six-degree-of-freedom, inertially-stabilized mount for the camera. It was operated in the fully flexible mode using operator tracking during this project.

(3) 70mm Motion Picture Camera System. The motion picture camera used in the project was a specially modified Mitchell FC-65 Todd-AO system. This was a variable-speed, variable-shutter camera with a 120° by 52° FOV lens (American Optical/Todd-AO). The camera was fitted with positive registering pins and was capable of producing satisfactory pictures at rates up to 30 frames per second. The camera was operated in reverse for the fixed-wing and rotary-wing pop-up phases of the project and in the normal (forward) mode during rotary-wing NOE filming. A special modification provided direct readouts of framing rate in both directions. Both shutter opening and lens aperture (f-stop) are manually adjustable; the shutter from 0° to 170° in 10° increments, and the lens from f-2 to f-16 in standard increments. Nominal magazine capacity was 1000 ft. Eastman Kodak 5254 color negative film was used. Camera specifications and installations are described in Annex A.

(4) Frame Camera System. Two Maurer 500 reconnaissance cameras were used to obtain briefing material. Both cameras used a three inch lens cone and provided an FOV of approximately 73°. One camera was mounted vertically in the bomb bay of the B-25G; the other was mounted in the tail of the aircraft at an optical axis depression angle of 20° from aircraft waterline. Both were controlled by velocity/height command voltage from a camera control unit which provided automatic operation with image motion compensation and a 60% frame overlap. Exposure adjustment was made by varying the focal plane shutter slit width. Nominal magazine capacity was 500 ft. of film. Eastman Kodak 3400 black and white film was used. Camera specifications and installation are described in Annex A.

(5) IR Line Scan Sensor. A Honeywell AN/AAS-27 IR sensor was used to produce IR imagery of the exercise area. The receiver, recorder, film magazine and associated power supplies and cooler were mounted in the bomb bay of the B-25G. The control panel and video monitor were mounted in the waist crew station, just aft of the bomb bay. The receiver was mounted in a 45° aft oblique position. Although the unit has integral roll stabilization, it was disabled for this project due to the mounting geometry.

(6) Instrumentation

(a) Spot Photometers. Two Spectra telephotometers were used to collect target/background luminance data to determine the inherent contrast of each target array. A 2° FOV was used for all measurements. Photometric techniques are described in Annex B.

(b) Meteorological Instruments. Meteorological instrumentation is described in Annex B.

(7) Resolution Targets.

(a) Trapezoidal Target. A specially-designed trapezoidal wedge target was used as the primary resolution target during the project. It was designed to provide a more accurate measure of resolution than would be possible with standard resolution targets. Due to its relatively small size (24 ft. high x 30 ft. wide) it was capable of being erected in a plane normal to the optical axis of the 70mm camera, thus overcoming the foreshortening evident with normal, horizontal targets. Details of construction and size derivation are contained in Annex A.

(b) Controlled Range Network. To verify the resolution data obtained from the trapezoidal target, a controlled range network (CORN) target array was deployed during 9-12 October adjacent to the trapezoidal target. Detailed descriptions of each target in the array are contained in Annex A.

c. Test Concept.

(1) A modified B-25G equipped with a Mitchell FC-65 Todd-AO motion picture camera, an AN/AAS-27 line scan IR sensor, and two Maurer 500 reconnaisance frame cameras was used to collect fixed-wing 70mm color motion picture imagery, IR imagery and black and white reconnaissance photographs of tactical target arrays. The Mitchell FC-65 Todd-AO motion picture camera was mounted in a UH-1H helicopter to collect rotary-wing pop-up color motion picture imagery and in an AH-1G helicopter to collect rotary-wing NOE imagery.

(2) The following parameters were varied at the levels shown during this project:

Fixed-wing flight altitude: 1000 and 3000 ft AGL
Target offset: 0, 200, 500, 1500 ft
Rotary-wing pop-up range: 1 and 2 km
Target type: M60 tanks and 2-1/2-ton trucks
Sun angle (relative to camera): 180° and 125°

Sun elevation: 50°-40° and 20°-25°
Target area clutter: none and moderate
Target/background contrast: low and high
Target IR signature: hot and cold

2. PURPOSE AND SCOPE OF THE PROJECT

a. Purpose. The overall purpose of Project IC1 is to insure the adequacy of the hardware, flight profiles, tactics and instrumentation to be used in the comprehensive collection effort; and if possible, to supply imagery for observer evaluation on the MMS.

b. Specific Objectives. The specific objectives of Project IC1 listed in order of priority, are to:

(1) Evaluate adequacy and suitability of imagery collection hardware to include aircraft, camera, instrumentation and installations.

(2) Identify and correct imagery collection/methodology/system deficiencies prior to the Part II collection effort.

(3) Develop and evaluate target placement procedures.

(4) Evaluate mission profiles for realistic simulation of combat air support operations.

(5) Collect and evaluate imagery for possible use in the Boeing MMS during the direct visual imagery experiment, Project IA2.

3. METHOD OF ACCOMPLISHMENT.

a. General.

(1) This project was intended to be an exploratory effort to determine an adequate methodology for the collection of fixed- and rotary-wing 70mm motion picture imagery and fixed-wing IR imagery. To accomplish this determination, fixed- and rotary-wing missions were flown against a variety of tactical target arrays located on the Hunter Liggett Military Reservation (HLMR), California. The missions were designed to fulfill the specific objectives of the project as described is section 2 of this report.

(2) Reference (b) contains the test matrices resulting from variables considered in the project. These matrices are reproduced here (Figures 1 & 2) including the mission/encounter (M/E) number which was intended to satisfy the appropriate cell requirements.

Fixed-Wing Encounters

Profile (ft)	Offset (ft)	Sun Elev	Sun AZ	Contrast/Clutter H/N R	H/N C	H/M R	H/M C	L/N R	L/N C	L/M R	L/M C
Dive	0	Min	125		92						91
			180								
		Max	125								
			180		102		101		81		82
3K	1.5K	Min	125								
			180								
		Max	125								
			180		34		44		33		43
	0.5K	Min	125		54*						53*
			180								
		Max	125								
			180	74*	14*	64*	24*	73*	13*	63*	23*
1K	1.5K	Min	125								
			180								
		Max	125								
			180		32		42		31		41
	0.5K	Min	125		52						51
			180								
		Max	125								
			180	12	72*	22	62*	11	71*	21	61*

Legend:

Contrast: H = High, L = Low
Clutter: N = None, M = Moderate
Target Signal: R = Running, C = Cold
* Denotes IR Coverage

Figure 1

Rotary-Wing Encounters

Pop-Up Range (km)	Offset Angle	Sun Elev	Sun AZ	Contrast/Clutter H/N	H/M	L/N	L/M
1.0	10°	Min	125	122			121
			180				
		Max	125				
			180	113	114	112	111
	30°	Min	125				
			180				
		Max	125				
			180	132			131
2.0	10°	Min	125				
			180				
		Max	125				
			180	154	153	152	151
	30°	Min	125				
			180				
		Max	125				
			180				
NOE Offset (ft)							
	200	Min	125	172			171
			180				
		Max	125				
			180	163	164	161	162
	500	Min	125				
			180				
		Max	125				
			180	182			181

Legend:

Contrast: H = High, L = Low
Clutter: N = None, M = Moderate

Figure 2

b. Specific. Annex E contains descriptions of the methods used during various phases of project operations.

c. Chronology. The following is a chronological listing of major events in the planning and operational phases of the project:

30 Jul 73	Project Office established at Ft. Ord, Ca., planning commenced
6-7 Aug 73	Project Manager (PM) planning conference at BAC
24 Aug 73	Project Plan first draft completed
29-30 Aug 73	JTF Review board of Project Plan
4 Sep 73	JTD and Service deputies approved Project Plan
5 Sep 73	PM briefed fourth SEEKVAL Program Review meeting on the Project
10 Sep 73	Arrival of 70mm camera and associated equipment at Tallmantz Aviation
19 Sep 73	Arrival of AAS-27 IR system at Tallmantz Aviation
25 Sep 73	Arrival of Maurer 500 cameras at Tallmantz Aviation
15-28 Sep 73	Installation, required repair, modification, tuning and re-installation of sensors in B-25 aircraft
29-30 Sep 73	Local area flight tests
1 Oct 73	B-25 to Monterey
2-15 Oct 73	Production and test runs at HLMR
16 Oct 73	Fixed-wing aircraft return to Tallmantz

13-14 Oct 73	70mm camera and mount installed in CH-47
15 Oct 73	CH-47 to HLMR
16 Oct 73	CH-47 test flights; aircraft determined unsuitable for imagery collection due to exhaust gas interference
17-18 Oct 73	Camera and mount installed in UH-1H; rotary wing pop-up production filming completed
18-19 Oct 73	Test flights made to assess rotary-wing NOE filming possibility in UH-1H; rotary-wing pop-up production filming completed
23-25 Oct 73	Modification of AH-1G and installation of 70mm camera
26-30 Oct 73	Production filming of rotary wing NOE missions from AH-1G; Project flight operation completed
6 Nov 73	Exit briefing by PM to BGEN Starker, CDR USACDEC
7 Nov 73	Project Office at Ft. Ord, Ca., closed

4. RESULTS AND DISCUSSION.

a. General. Annex E contains a discussion of project results as they were known at that writing. In some cases additional information has resulted in the modification of results contained in that report. It must be noted that the project imagery is still being evaluated and that these results may be modified as further data becomes available.

b. Target Array Location.

(1) Contrast. Photometric data taken during the planing phase of the project indicated that sufficient differences existed in the background reflectances of the chosen locations to provide the desired levels of target/background contrast.

Planning was therefore completed using these locations. Subsequent to the completion of planning and the commencement of operations, however, environmental factors were sufficient to change one location from low contrast to high contrast. Specifically, the grass ashes which made up the dark background of location 6476387967 were dispersed by wind, rain, and traffic to the point where the area was virtually bare and produced a high contrast value. A second area of lush green grass which was a low contrast area at the commencement of project operations was eaten and trampled by a herd of cattle until it was appreciably lighter in color and higher in contrast. A tabulated list of contrast values versus time is included as Appendix 2 to Annex C.

(2) Clutter. WSEG/IDA, in their test design, suggested and defined the two levels of clutter that were used in the project:

(a) None-vehicles in a large open area that is void of objects having characteristics similar to those of the vehicles. For this project, the area was taken to be a circle with a radius of about 200 meters.

(b) Moderate-vehicles located such that the surrounding area has some objects (approximately 20 within a radius of about 200 meters) which have characteristics similar to those of the vehicle (e.g., trees). Appendix 3 to Annex C contains a tabulation of the actual number of "target-like objects" within a radius of 200 meters from each target location. From these data, it can be seen that the foregoing definition of moderate clutter could be applied in all cases, yet study of photographs of the fixed-wing target locations (Figures 3 thru 6) clearly illustrates the lack of clutter in the immediate vicinity of the array for the "no-clutter" locations.

c. Ground Operations.

(1) Vehicle Cleanliness. Although considered necessary for 70mm filming, it was recognized that the field wash-downs did change the vehicles IR signature. For this reason, no wash-downs were performed when the scheduled mission was solely IR. Wash-downs were performed with the vehicles in their final location. Due to the atmospheric conditions and time involved the resulting ground watermark was not visible to the naked eye or the 70mm camera by the time production runs were commenced. Examination of the IR imagery, however, disclosed that, in some cases, for example, M/E24, the damp earth produced a large blotch on the image which obscured the target vehicles completely.

Figure 3

Location 644882 Low Contrast No Clutter

Figure 4

Location 645798 High Contrast No Clutter

Figure 5

Location 648880 Low Contrast Moderate Clutter

Figure 6

Location 661805 High Contrast Moderate Clutter

d. Sensor Operation.

(1) Fixed-Wing.

(a) Mitchell FC-65 70mm Camera. Color contrast, resolution, color balance, exposure, and recorded frame rates all meet expectations, and, with few exceptions, produce high quality films. Microdensitometer measurements of the resolution targets indicate that high-contrast limiting resolution on the order of 28 lines/mm was obtained. Close examination of the imagery disclosed an intermittent blurring on every 12th frame of some runs. The effect is not noticeable on playback, however, and was probably caused by slightly out-of-synch propellers. On the whole, however, the B-25/Mitchell system produced good, stable, constant speed imagery. Much of the imagery, however, was taken with slant ranges to the targets much too long to permit adequate target definition. Particularly those encounters at 3000 ft. AGL, although tactically more realistic, generated imagery with extremely limited usefulness.

(b) Maurer 500 Frame Cameras. The frame cameras required a great deal of bench testing and checking prior to becoming operational. Reference (c) details the problems encountered in obtaining proper camera operation. Once operational, however, the cameras produced excellent results. On the oblique imagery, detail features of the targets are discernable, roadwheels, tracks, insignia, and guns. The vertical imagery also produces excellent target detail although the 1:20,000 scale is a bit small for detail examination of targets of this type.

(c) AN/AAS-27 Line Scan IR Sensor.

1. General. Although evaluation of the IR imagery collected during the project is incomplete, preliminary results indicate that the system's performance was considerably poorer than expected. While it is not possible to assess their relative importance, the following factors appear to be the major causes of the observed degradation.

a. Sensor Mounting and Geometry. The system scanner was mounted in the bomb-bay of the B-25 at a 45° aft oblique position. Due to time constraints imposed by project milestones, design and procurement of suitable shock mounts for the scanner was not possible; thus the scanner was rigidly mounted to the airframe and susceptible to airframe vibration. In addition, the 45° oblique mounting required that the integral roll stabilization of the system be disabled. These two factors combined to degrade the angular resolution of the system to 3.5 milliradians in the cross-track direction and 6.0

milliradians in the along-track direction. The lack of stabilization caused serious distortions due to short-term aircraft pitch, roll, and yaw excursions.

b. Daytime Flight Conditions. During daylight hours, the IR signature of an object is a composite of its own emissivity and the reflected incident radiation. Since most incident radiation is generated by the sun in the visible and near IR portion of the spectrum, it may be filtered by use of a suitable material. Once the reflected wavelengths have been filtered, only emitted radiation will be observed by the sensor and a true thermal image will be obtained. The AAS-27 system does not include a filter for daytime use; consequently the imagery was generally degraded due to visible and near IR wavelengths. Some examples of this are available in the imagery. In a few cases a cloud shadow covers the target area and the solar energy was significantly reduced. The targets in these situations are more readily discernible than on any of the other films due to a much improved thermal resolution capability. The imagery was further degraded due to the requirement to utilize a very low gain setting to prevent saturation of the recorder by the high ambient energy levels.

(2) Rotary-Wing.

(a) Pop-up. Pop-up encounters were accomplished shooting sideward from a UH-1H. The UH-1H in combination with the Tyler mount produced a stable, agile platform for this imagery, and few problems were encountered. As was the case in the fixed wing imagery, the slant ranges at the far pop-up distance (2KM) were excessive for good definition and some target/background contrast levels were too low. In addition, marked pop-up locations were so near the crest of the masking hill that masking was impossible without being too close to the hill for an operationally realistic presentation. These locations were moved back from the hill approximately 100 ft. during filming, and the resulting films were acceptable although the unmasked time was unrealistically long.

(b) Nap-of-the-Earth. NOE 70mm imagery was collected using a pedestal mount in the nose battery compartment of an AH-1G. The resulting film is excellent in terms of image quality, aircraft stability, clarity, and tactical realism. However, because of the manner in which the camera mount was constructed, there was a cyclic (approx. 0.5 sec. period) camera vibration which occurred during filming and is noticeable in playback. Also, some courses were flown which brought the sun azimuth too close (about 260° relative) to the nose causing sun spots to appear on the film. As in the fixed-wing case, but to a much greater degree, tree and shadow masking on some encounters preclude seeing the targets when they should be easily within viewing range.

e. Photometric Procedures. Analysis of the photometric data was performed by the Air Weather Service. This analysis and evaluation are contained in Appendix 1 to Annex B.

f. Meteorological Results. Meteorological data, as well as the evaluation of the special meteorological instrumentation are contained in Appendix 2 to Annex B.

5. CONCLUSIONS.

a. General. Conclusions are presented as they relate to a specific objective of the project.

b. Specific.

(1) Objective 1.

(a) The aircraft (B-25, UH-1H, and HH-1) used in this project are suitable for the collection of imagery in future projects.

(b) The Mitchell and Maurer 500 cameras produced excellent results and are suitable for use in future projects.

(c) The AN/AAS-27 produced unsatisfactory imagery under the conditions used in this project.

(d) Photometric and meteorological instrumentation used in this project was suitable with the following exceptions.

1. A larger spot size would have been desireable for the portable photometers.

2. A pyranometer is not necessary for future projects.

(e) The sensor installations used in the project were adequate except for the following deficiencies:

1. The 70mm camera mount on the AH-1G was approximately three inches taller than necessary causing a periodic (about 2 Hz) vibration that appears in 70mm playback.

2. The AN/AAS-27 45° mounting required that the roll stabilization of the system be disabled, causing distorted imagery due to aircraft motion.

(2) Objective 2.

(a) The multiple-point method of photometry provides consistent, repeatable results.

(b) For the limited sample collected in this test, there are significant differences between vehicle luminances taken at various azimuths using the multiple-point method. Possible differences using the area method were not investigated.

(c) There are no significant differences between the multiple-point and area methods for obtaining vehicle luminances for the limited samples collected in this test.

(d) There are significant differences between the multiple-point and area methods for obtaining background luminances for the limited samples collected in this test.

(e) Multiple gray card readings should be made for each set of target or background readings.

(f) Microdensitometer measurements of apparent contrast should duplicate the photometer techniques as closely as possible.

(3) Objective 3.

(a) A large-scale aerial mosaic is useful in the preliminary site selection process.

(b) It is not operationally possible to obtain and maintain precisely pre-determined contrast values, although rough classification into low and high contrast is feasible.

(c) Contrast values less than ± 0.3 will result in unacceptably short available ranges.

(d) The definition of clutter used in this project in not realistic.

(e) Target arrays must be carefully positioned to insure adequate intervisibility times for all flight conditions.

(4) Objective 4.

(a) The relatively low altitude required for fixed-wing filming is not a realistic combat air support profile, however, due to the limited resolution of the overall system compared to the human eye it is necessary to minimize near point slant range.

(b) The unmasked time of rotary-wing pop-up maneuvers used in this test exceeds that which is operationally acceptable; however, since time-to-acquire is the primary measure of effectiveness in this situation, it is necessary.

(c) The rotary-wing NOE profile is operationally realistic, especially when combined with a pop-up maneuver.

(5) Objective 5.

(a) Most of the 70mm imagery is well suited for use in the Boeing facility.

(b) The IR imagery is not suitable for use due to the lack of resolution.

(c) The frame camera imagery is usable as briefing material.

6. RECOMMENDATIONS.

a. General. Recommendations are presented as they relate to a specific objective of the project.

b. Specific.

(1) Objective 1.

(a) Utilize the B25/Mitchell camera system for future fixed-wing 70mm collection efforts.

(b) Utilize the AH-1/Mitchell camera system for future rotary-wing 70mm collection efforts.

(c) Design and fabricate a pedestal mount for an AH-1 to minimize the airframe vibration problem.

(d) Utilize the Maurer 500 systems to obtain the necessary frame photography for future efforts.

(e) Modify the Maurer 500 oblique mounting in the B-25 to eliminate the camera body distortion problem.

(f) Locate and acquire an alternate IR line scan sensor for use in future efforts. The sensor should:

1. Be shock-mounted in the aircraft.

2. Be stablized in pitch and roll.

3. Be filtered for daylight operation.

(g) Utilize the trapezoidal resolution target concept on future efforts.

(h) Obtain portable photometers with:

1. A larger spot size (about 30 degrees), and,

2. Sufficient battery power for extended (4-5 hour) operation.

(i) Obtain the following meteorological instruments for future efforts:

1. Integrating nephelometer (MRI 2050) capable of remote (battery-powered) operation.

2. Portable RPMI.

3. Illumination telephotometer.

(2) Objective 2.

(a) Allow at least one month for aircraft configuration and sensor check-out prior to commencing operations.

(b) Utilize the area method of determining vehicle reflectances.

(c) Utilize the multiple-spot method for determining background reflectances in fixed-wing operations.

(d) Utilize the area method for determing background reflectance in rotary-wing operations.

(e) Perform a preliminary study on reflectance variations by azimuth for the area method of photometry.

(f) Locate the meteorological instrumentation as near as feasible to the target locations.

(3) Objective 3.

(a) Task USN/USAF to produce an uncontrolled 1:10,000 aerial mosaic of future exercise areas.

(b) Task WSEG/IDA to produce a more realistic definition of clutter for future projects.

(c) Formalize a 4-step method of target array location, as follows:

1. Initial target array location using a large-scale aerial mosaic.

2. Personal reconnaissance of proposed locations by personnel responsible for location selections.

3. Collect background photometer data to determine the range of contrasts available.

4. Flight check each location to ensure that adequate intervisibility range exists.

(4) Objective 4. Retain the present flight parameters for both fixed- and rotary-wing operations.

ANNEX A

EQUIPMENT DESCRIPTIONS

This annex contains the specifications of the equipment used in the project. Included are details of installations and construction of the AH-1G pedestal mount and the trapezoidal resolution target.

APPENDIX 1

ANNEX A

MITCHELL FC-65 TODD-AO MOTION PICTURE CAMERA

1. SYSTEM SPECIFICATION.

Type:	Mitchell FC-65 TODD-AO, 65mm
Shutter Speed:	1/125 sec. (can be varied from 1/30 to 1/8000 sec.)
Shutter Type:	Manual (adj. in 10° increments from 0° to 170°)
Frame Rate:	Up to 30 frames/sec.
Lens:	American Optical, 18.7mm (f2.0)
FOV:	120° lateral, 52° vertical
Power Requirement:	28 ±0.5 vdc (peak load of 12 amps)
Magazine:	1000 feet
Film:	Eastman Kodak 5254 (color), ASA = 64

2. OPERATING PARAMETERS.

	Fixed-wing	Rotary-wing Pop-up	Rotary-wing NOE
Frame Rate (frames/sec.):	15	24	20
Shutter Opening (degrees):	50°	70°	60°
Resolution (lines/mm):	28	NA	28

3. POWER SUPPLY.

a. B-25G. Due to instabilities in the aircraft DC power, camera power was supplied by tapping the 115v, 400 Hz AC system and inverting it to provide the necessary stability.

b. UH-1H. Power was obtained by a direct tap into a 28 vdc utility receptacle in the aircraft cargo compartment.

c. AH-1G. Power was obtained by a direct tap into a 28 vdc test receptacle located on the aft bulkhead of the battery compartment.

4. CAMERA MOUNTS.

a. B-25G. The camera was mounted in the tail of the aircraft with an optical axis depression angle of 13° from the aircraft waterline. The camera baseplate was bolted directly to an existing mounting plate in the aircraft.

b. UH-1H. The camera was mounted on the Tyler 806M camera mount which, in turn, was tied down in the aircraft cargo compartment.

c. AH-1G. Mount details are described in Tab A to this appendix.

TAB A

APPENDIX 1

ANNEX B

MULTIPLE POINT METHOD EVALUATION

1. Repeatability. Table 1-B-1 contains the average of target and background photometer readings taken at differing times on the same day. Luminances are given in foot-Lamberts (fL). The data indicate both a high degree of repeatability of same day readings, and an indication that luminances will remain relatively constant over a days shooting time. This would obviate the requirement for repeated photometer data on a given day. It should be noted, however, that while the average luminances are about the same, individual spot readings sometimes showed large variations indicating the need for several points when using a narrow FOV photometer. A photometer with a wider FOV would have lessened this effect by providing better averaging at the short ranges used.

2. Angular Differences. Table 1-B-2 illustrates the differences in luminance which can occur with varying azimuths. While the differences may not be as significant with an area method of data collection, this effect should be investigated prior to IC2 data collection.

TABLE 1-B-1

MULTIPLE POINT REPEATABILITY

Vehicle Type	Tgt. Loc.	DTG	Luminance (fL)	Percent Difference
2-1/2-ton	644882	031300 031350	540.5 524.7	2.3
M-60	661805	041250 041350	758.6 777.4	2.5
2-1/2-ton	648880	101215 101325	686.2 677.8	1.2
M-60	661805	101220 101315	782.1 804.4	2.9
M-60	661805	101245 101335	735.0 808.1	9.1
M-60	645798	111255 111345	777.2 955.2	23.0 (1)
Background	645798	111305 111350	1444.6 1376.4	4.7

Note: 1. Large difference due to cloud shadow.

TABLE 1-B-2

ANGULAR DIFFERENCES

2-1/2-ton Truck - Location 648880 - DTG 101325 PDST

Point	Luminance (fL) Normal	Luminance (fL) Deflected	% Difference
1	385	476	23.6
2	517	525	1.5
3	1230	1148	6.6
4	902	1066	18.1
5	705	738	4.7
6	328	492	50.0
Mean	678	741	9.3

M-60 Tank - Location 661805 - DTG 101315 PDST

Point	Luminance (fL) Normal	Luminance (fL) Deflected	% Difference
1	1820	1638	10.0
2	710	546	23.1
3	346	328	5.2
4	382	237	38.0
5	764	673	11.9
Mean	804	684	14.9

Normal - Readings taken at 90° to longitudinal axis of vehicle and 30° depression.

Deflected - Readings taken at 45° to longitudinal axis of vehicle and 30° depression.

TAB B

APPENDIX 1

ANNEX B

MULTIPLE POINT/AREA COMPARISON

1. General. The data contained in this section provides the basis for a comparison between the two methods of photometry that were used during the project. The small difference (i.e., less than 10%) found between the two methods of determining vehicle reflectances is important because of the significant time savings and potential increased accuracy of the area method due to the effect of averaging over the entire region within the FOV. While the background data cannot be compared in the same way due to the depression angle differences, the expected trend is indicated, i.e., lower background values for 0° depression due to the inclusion of dark vegetation.

TABLE 1-B-3

VEHICLE DATA

Type	Location	DTG	Luminance (fL)			Reflectance		
			Pts	Area	% Diff	Pts	Area	% Diff
M-60	644798	111650	346	455	32	.082	.082	0.0
2-1/2-ton	648880	181410	635	607	4.4	.077	.070	10
2-1/2-ton	648880	181430	657	610	7.1	.080	.079	1.2
M-60	638800	181405	790	792	0.2	.086	.092	7.0
M-60	638800	181410	841	901	7.0	.097	.105	7.2
Means			654	673	2.9	.085	.086	1.2

TABLE 1-B-4

BACKGROUND DATA

Area	Location	DTG	Luminance (fL)			Reflectance		
			Pts	Area	% Diff	Pts	Area	% Diff
North	648880	181410	1680	1381	17.9	.205	.160	27.0
North	648880	181430	1938	1539	20.7	.236	.204	15.7
South	638800	181420	1650	1436	13.0	.218	.173	20.7
South	638800	181435	1422	1486	4.5	.165	.184	11.5
Means			1672	1460	12.7	.231	.180	22.0

TABLE 1-B-5

CONTRAST DATA

Type	Location	DTG	Vehicle #	Contrast Points	Contrast Area	% Diff
2-1/2-ton	648880	181410	1	-.62	-.56	9.7
			2	-.66	-.61	7.5
			Avg	-.64	-.59	8.4
M-60	638800	181405	1	-.52	-.47	9.6
			2	-.41	-.43	4.9
			Avg	-.47	-.45	4.2

Note: Background points taken at 30° depression.

TAB C

APPENDIX 1

ANNEX B

CDEC/MEAD COMPARISON

1. General. During the period of deployment of the CORN target array, Mead Technology Laboratory personnel made independent photometric measurements on one target/background combination to obtain comparison data for the CDEC measurements. Mead's data was obtained with a Spectra Spot Brightness Meter using a 2-1/2° spot size.

2. Specific. The data tabulated below were measured on a 2-1/2-ton truck in the moderate clutter area (648880) on 12 October 1973. Detailed data is presented only for the #2 (Easternmost) vehicle and its background, while average data is tabulated for the #1 (Western) vehicle background only. Differences are computed by:

$$\text{Diff} = \left(\frac{\text{CDEC-MEAD}}{\text{MEAD}}\right) \times 100$$

TABLE 1-B-6

VEHICLE DATA

Luminance (fL)

Point	1	2	3	4	5	6	Mean
CDEC	490	738	1148	492	1148	656	779
MEAD	510	610	710	410	940	600	630
Diff	-3.5	21.0	61.7	18.7	22.2	9.3	23.6

Reflectance (dimensionless)

Point	1	2	3	4	5	6	Mean
CDEC	.049	.073	.114	.049	.114	.065	.077
MEAD	.050	.055	.073	.043	.087	.057	.063
Diff	-2.0	32.7	55.2	13.9	31.0	14.0	22.2

Total Illumination

(a) CDEC. One reading from 18% gray card taken at 1317 - 10020 fL.

(b) Mead. Average of six readings from a 33% gray card taken between 1325 and 1330 - 10340 fL.

TABLE 1-B-7

BACKGROUND DATA

Luminance (fL)

Point	000	045	090	135	180	225	270	315	Mean
CDEC	1968	1968	2214	2050	2132	1968	1804	2296	2075
MEAD	2700	2175	2400	2200	2300	2910	2100	2100	2361
Diff	-27.2	-9.5	-7.8	-6.8	-7.2	-32.0	-14.1	-9.3	-12.1

Reflectance (dimensionless)

Point	000	045	090	135	180	225	270	315	Mean
CDEC*	.196	.196	.220	.204	.213	.196	.180	.229	.207
MEAD	.248	.206	.240	.214	.237	.306	.198	.193	.225
Diff	-20.8	-4.9	-8.3	-4.7	-10.2	-36.0	-9.2	18.6	-8.8

Total Illumination

(a) CDEC. One reading from 18% gray card taken at 1300 - 15444 fL. This value is far too high, probably due to glare; background reflectances were computed using the 1317 reading taken with the vehicle data.

(b) Mead. Average of eight readings from a 33% gray card taken between 1314 and 1325 - 10511 fL.

TABLE 1-B-8

WESTERN BACKGROUND DATA

	CDEC	MEAD	Diff
Luminance (fL)	1906	2044	-6.8
Reflectance (dimensionless)	.223	.264	-15.5

3. Area/Spot Comparison. These data illustrate the relative consistency of area and spot values for vehicle data. Also shown is the large variation possible in background values.

a. Vehicle

Condition	Reflectance (dimensionless)
Average of 6 points at 30° depression	0.063
One point at 225 feet, 0° depression (hood and tire)	0.068
One point at 150 feet, 0° depression (rear tire and hub)	0.060

b. Background

Condition	Reflectance (dimensionless)
Average of 8 points at 30° depression	0.225
Average of 2 points at 225 feet - small depression (ground below vehicle)	0.284
One point at 225 feet - small elevation (tree foliage)	0.044

4. <u>Evaluation</u>. Since neither set of measurements has proven to be significantly more accurate than the other, these data primarily serve to show that the multiple point averaging method of obtaining photometric data results in luminance and reflectance values with 10 to 20% error. The fluctuations in 18% gray card readings indicate that more than one measurement is needed and care must be taken to avoid glare. The vehicle data indicate that readings of large areas taken at some distance can approximate the results of the close multiple point averaging method. The variations in background values with a slight change of depression angle, however, illustrate the uncertainty of this method for background measurements.

TAB A

APPENDIX 1

ANNEX A

AH-1G PEDESTAL MOUNT

1. Figure 1-A-1 illustrates the mount used in the AH-1G during this project. The mount was fabricated at the USACDEC machine shop, Ft. Ord, Ca., from 1/4 in. aluminum plate. All joints were welded using a Heliarc process. Due to an error in measurement, the mount is approximately three inches taller than necessary for camera control clearance. This extra height may have contributed to the vibration which is evident on the NOE imagery. The mount was secured to the floor of the battery compartment and to the aft bulkhead of the compartment. The battery was placed in the alternate battery location.

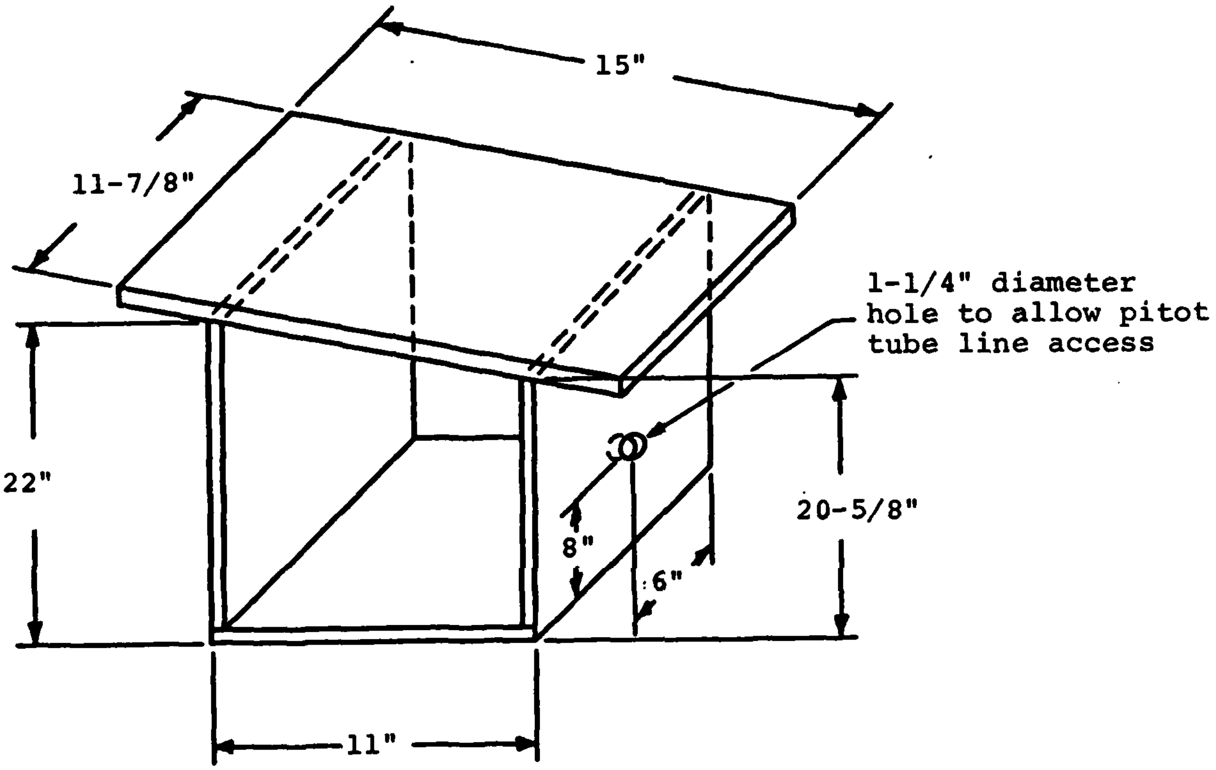


Figure 1-A-1

AH-1G Pedestal Mount

APPENDIX 2

ANNEX A

MAURER 500 FRAME CAMERA

1. SYSTEM SPECIFICATION.

Type:	Maurer Model 500
Format Size:	4.5 in. x 4.5 in.
Lens Focal Length:	3-in. (73° FOV)
Shutter Type:	Focal plane
Shutter Speed:	1/200 to 1/8000 in discrete steps
Frame Rate:	Up to 5 frames/sec
Weight:	38 pounds
Power Requirement:	27 $\pm$3 vdc, 15 amps
Dimensions:	14.5 in. length x 11 in. width x 16.75 in. height
Magazine:	500 feet
Film:	Eastman Kodak 3400 (black and white), ASA = 65

2. OPERATING PARAMETERS.

	Vertical	Oblique
Shutter Speed (sec)	1/1000	1/1000
Altitude (feet)	5000 AGL	Various

3. POWER SUPPLY. Camera drive and control voltage was obtained directly from the aircraft (B-25) 28 vdc bus.

4. CAMERA MOUNT.

a. Vertical. The vertical camera was mounted in the B-25 bomb-bay on the starboard bomb-bay door which was locked in the closed position. Camera access was possible through the port bomb-bay door on the ground and from the waist crew station while airborne.

b. Oblique. The oblique camera was mounted in the tail of the aircraft, above and to the left (looking aft) of the Mitchell FC-65. The camera mount was one inch plywood with a reinforcing plate of aluminum on the exterior surface. The camera body mated with the plywood surface while the mounting nuts were on the aluminum side. This configuration caused some camera problems due to uneven tightening of the mounting bolts which resulted in sufficient distortion of the camera body to prevent proper functioning.

APPENDIX 3

ANNEX A

AN/AAS-27 IR LINE SCANNER

1. SYSTEM SPECIFICATION.

a. Size and Weight:

	Size (cubic feet)	Weight (pounds)
Receiver (include Cooler):	2.04	105
Magazine:	.87	36.5 (unloaded)
Recorder:	3.50	155
Control Panel:	.06	4
Power Supply #1:	.25	13
Power Supply #2:	.97	51.5
Monitor:	.12	8.5
Total Cubic Feet of package:	7.81	
Total Weight:		371

b. Power Requirement: 28 vdc.

2. POWER SUPPLY. System power was provided by a direct tap from the aircraft 28 vdc bus.

3. SENSOR MOUNT. The receiver, recorder, film magazine, and associated power supplies were mounted in the forward portion of the B-25 bomb-bay. The control panel and video monitor were located in the waist crew station. All components were hard-mounted to the aircraft structure on a frame of 1 in. angle iron. The receiver was mounted in a 45° aft oblique position. Access to the system was possible on the ground through the port bomb-bay door.

APPENDIX 4

ANNEX A

TRAPEZOIDAL RESOLUTION TARGET SIZING

1. INTRODUCTION. Derivation of the specific size of a trapezoidal resolution target tailored to a set of pre-determined operational and equipment specifications is shown. The primary purpose of using this type of target versus the standard USAF bar targets is to achieve continuous resolution capability as a function of range at a comparative smaller physical size.

2. OPERATION/CAMERA PARAMETRIC REQUIREMENTS.

Altitude:	1000 feet
Depression Angle:	13°
Lens FOV	
Lateral:	120°
Vertical:	52°
Film Resolution:	15 lines/mm (assume modulation transfer response of 80%)

3. MATHEMATICAL DERIVATION.

a. Equivalent focal length (f) for 120° lateral FOV:

$$2 \tan^{-1} \left(\frac{65}{2f}\right) = 120°$$

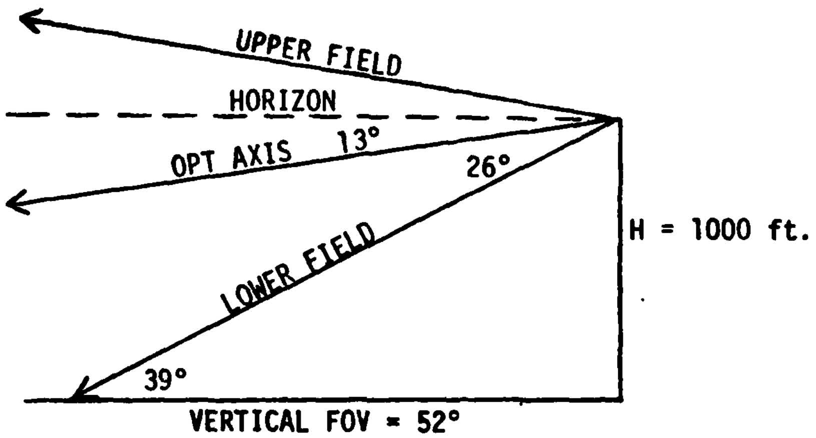
$$\tan^{-1} \left(\frac{65}{2f}\right) = 60°$$

$$f = \cot 60° \left(\frac{65}{2}\right)$$

$$= .577 \ (32.5)$$

$$= \underline{18.7 \text{ mm}}$$

b. Slant range derivation geometry is shown as:



Minimum slant range is thus:

$$SR_{min} = \frac{1000}{\sin 39°}$$

$$= \underline{1589 \text{ feet}}$$

c. Bar size derivation:

$$x = \frac{\text{(slant range)}}{\text{(Film Res.) (Equiv. Focal Length)}}$$

$$= \frac{1589}{(15)\ (18.7)}$$

$$= \underline{5.66 \text{ feet}}$$

where: x = combined width of Bar + Space at min. detect distance

For convenience in construction, this was rounded off to 6 feet. Figures 4-A-1 and 4-A-2 show the finished target and construction details, respectively. The target was mounted at an angle of 13° from the vertical and at right angles to the aircraft flight path.

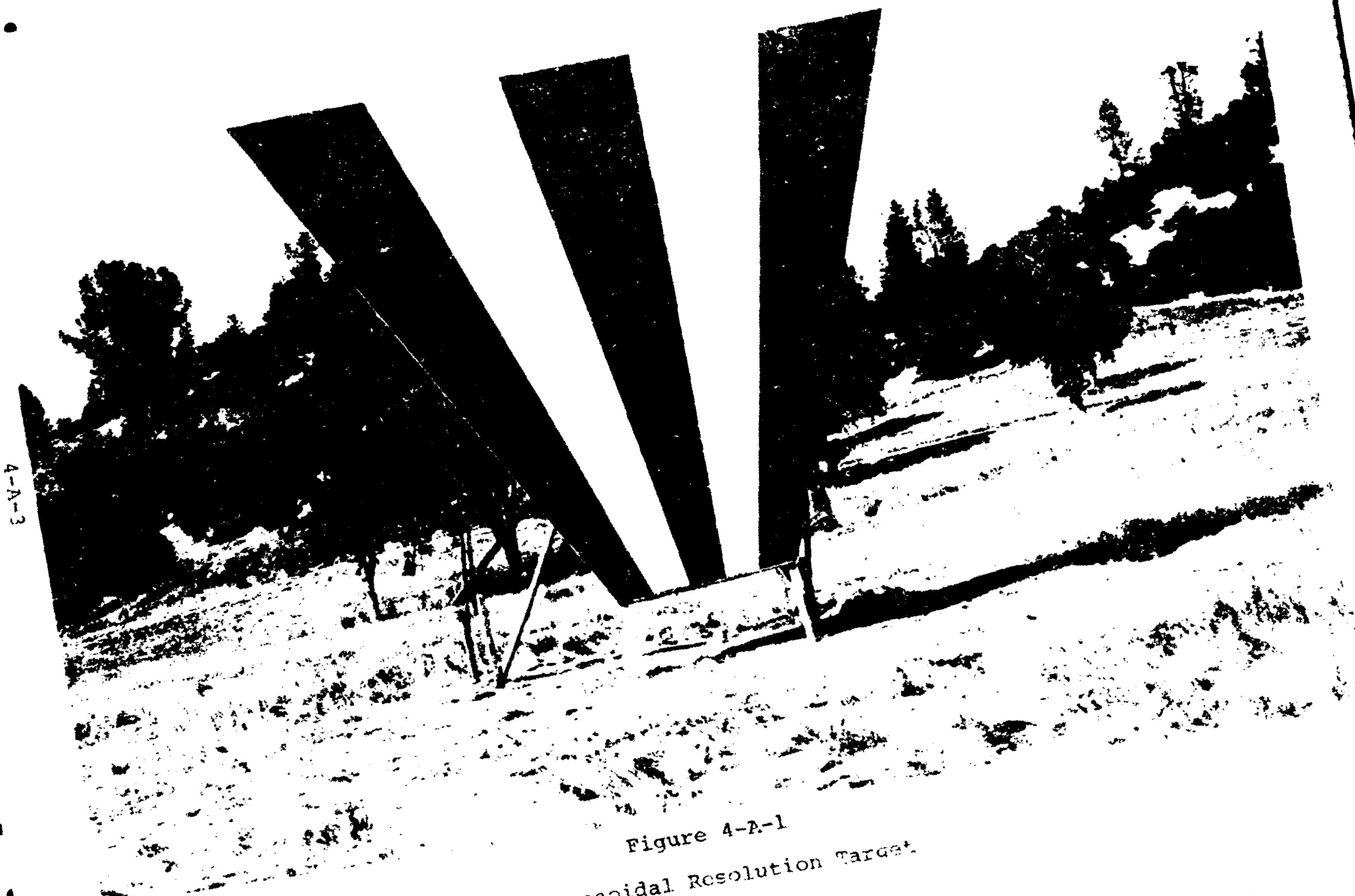


Figure 4-A-1

Trapezoidal Resolution Target

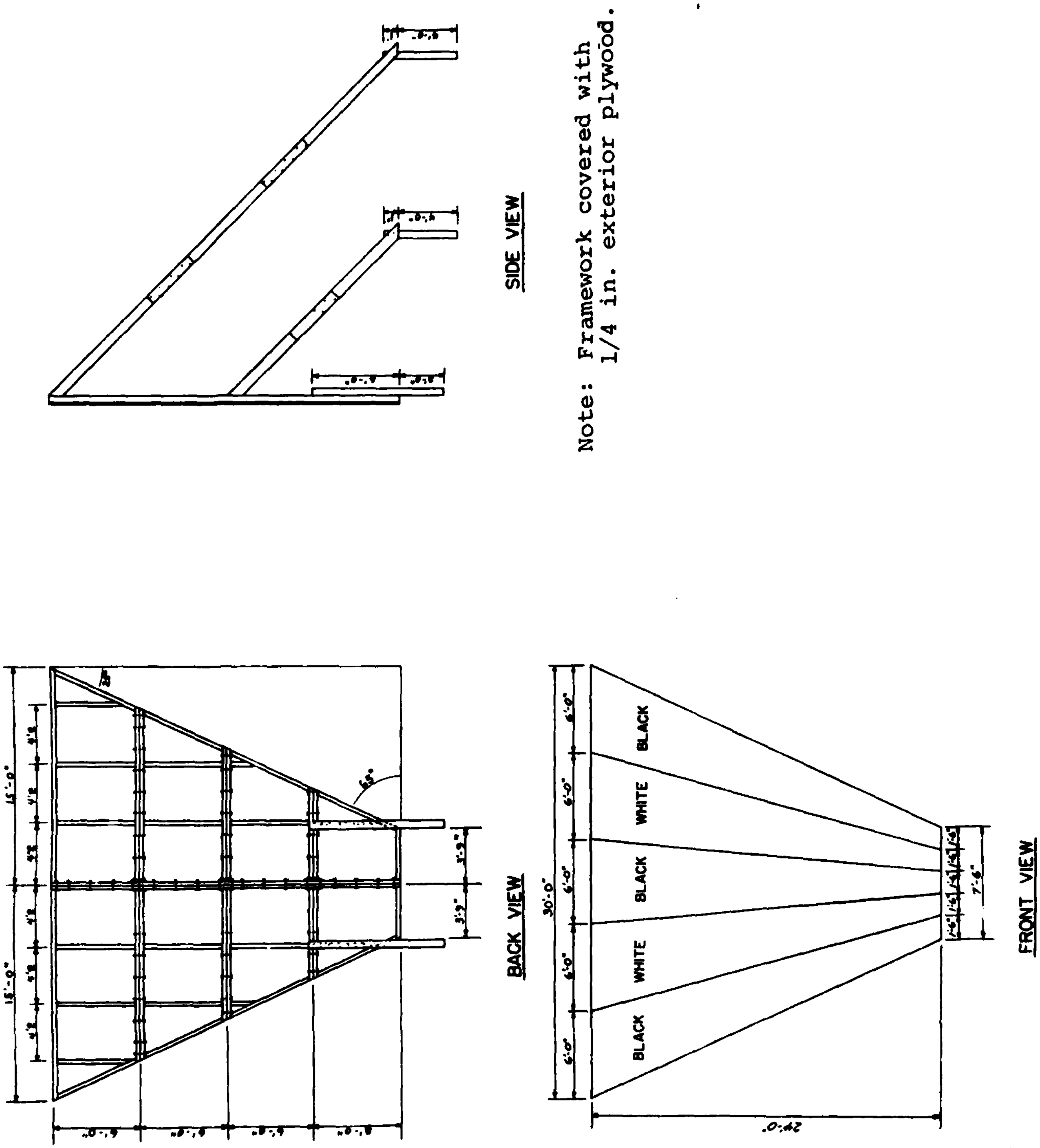


Figure 4-A-2

TRAPEZOIDAL RESOLUTION TARGET CONSTRUCTION DETAILS

4. RELATIVE RESOLUTION. Microdensitometer scans of 70mm fixed- and rotary-wing imagery provided the following resolution data:

Target	Resolution (lines/mm)
Trapezoid (fixed-wing)	29
Mil Std 150A (fixed-wing)	27
Trapezoid (rotary-wing)	29

APPENDIX 5

ANNEX A

CONTROLLED RANGE NETWORK TARGETS

1. BACKGROUND. To provide back-up and comparison resolution targets and specialized IR targets, a Controlled Range Network (CORN) target array was deployed adjacent to the trapegoidal target. It was deployed by Mead Technology Laboratories under contract to SEEKVAL during the period 9 - 12 October 1973. Figure 5-A-1 illustrates the array.

2. DESCRIPTION.

a. General. Four targets were deployed in the array. Reference (d) contains detailed descriptions of each target; however, a limited description is provided below.

(1) Modified Mil-Std 150A. This target is comprised of 37 bar groups displayed in a rectangular format. It has been modifed by the addition of two 15 ft. square black and white contrast patches with the same reflectance values as the bars and background.

Size: 97 ft. 2 in. x 99 ft. 8 in. (excludes the contrast patches)

Bar Size:
Largest: 4 ft. x 20 ft.
Smallest: 0.56 in. x 2.8 in.

Reflectance:
Bar: 90%
Background: 4%

Contrast Ratio: 22:1

(2) 51 - 51 "T" Bar. This target consists of two 381 ft. legs each consisting of 21 gray bar groups on a black background. The target is normally displayed with one leg parallel to the line of flight, the other perpendicular to it.

Bar Size:
Largest: 8 ft. x 40 ft.
Smallest: 6.0 in. wide

Reflectance:
Bar: 33%
Background: 7%

Contrast Ratio: 5:1

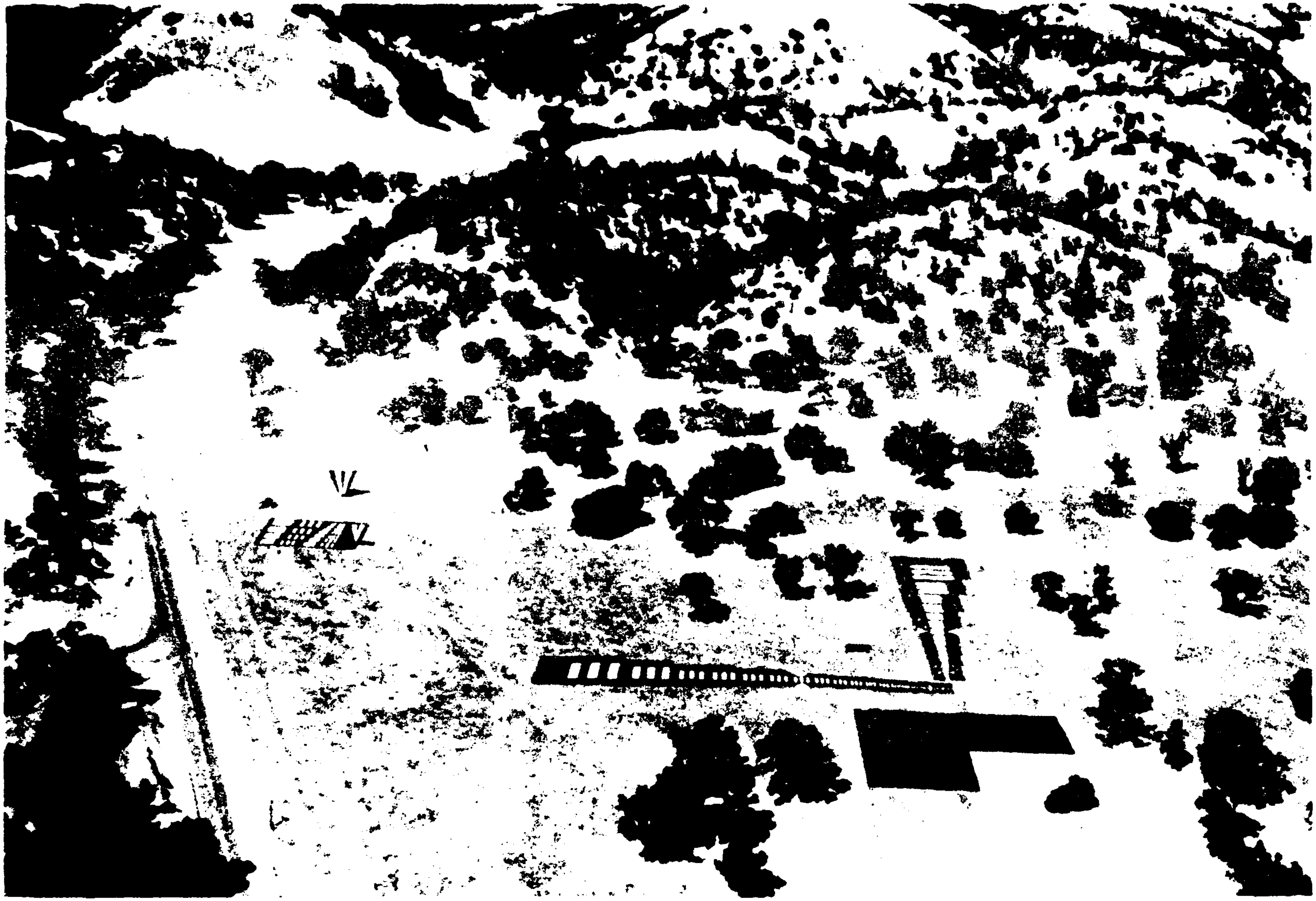


Figure 5-A-1

CORN Target Array

(3) Tri-Color. This target is composed of three, 20 ft. x 20 ft. targets. It was displayed in the order, red-green-blue with the red panel on the west end.

(4) IR Edge. This target is composed of three 100 ft. square sections, two of which have high IR emissivity, while the third has a low IR emissivity. The target was displayed so that it presented 100 ft. edges in both line-of-flight and across-line-of-flight directions.

ANNEX B

INSTRUMENTATION

This annex contains details of photometric and meteorological instrumentation, procedures, and results.

APPENDIX 1

ANNEX B

PHOTOMETRIC PROCEDURES AND RESULTS

1. INTRODUCTION. Photometric measurements were taken by Army and contractor personnel to determine target contrast values of both calibration targets and vehicle targets. This appendix considers the instruments and the methods used to take the photometric measurements.

2. GENERAL. The photometric data were collected by two teams of CDEC personnel using Spectra Pritchard Telephotometers as described in reference (b). The fixed-wing encounter measurements were made as outlined in Annex E of reference (b) using the vehicle points shown in Figures 1-B-1 and 1-B-2. The 18% gray card readings were added to allow reflectance values to be computed and to allow a monitor of the illumination levels on site. A significant amount of time can elapse between the background and vehicle measurements and the use of reflectances compensates for any changes in illumination occuring between the sets of measurements. The use of reflectance values also eliminates any problems caused by calibration shifts of the instruments. The rotary wing measurements were made following the procedures described in Annex E. Several comparison tests were made to assist in the evaluation of the photometric data. Tabs A, B, and C contain the results of these comparison tests. Target/background contrast data is tabulated in Annex C of this report.

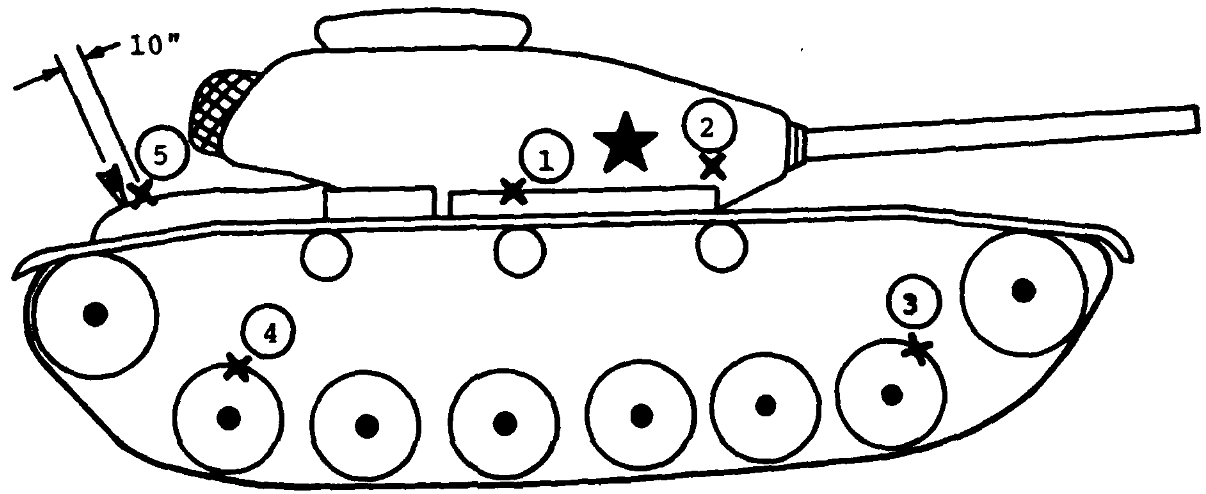


Figure 1-B-1

M-60 Tank Photometric Points.

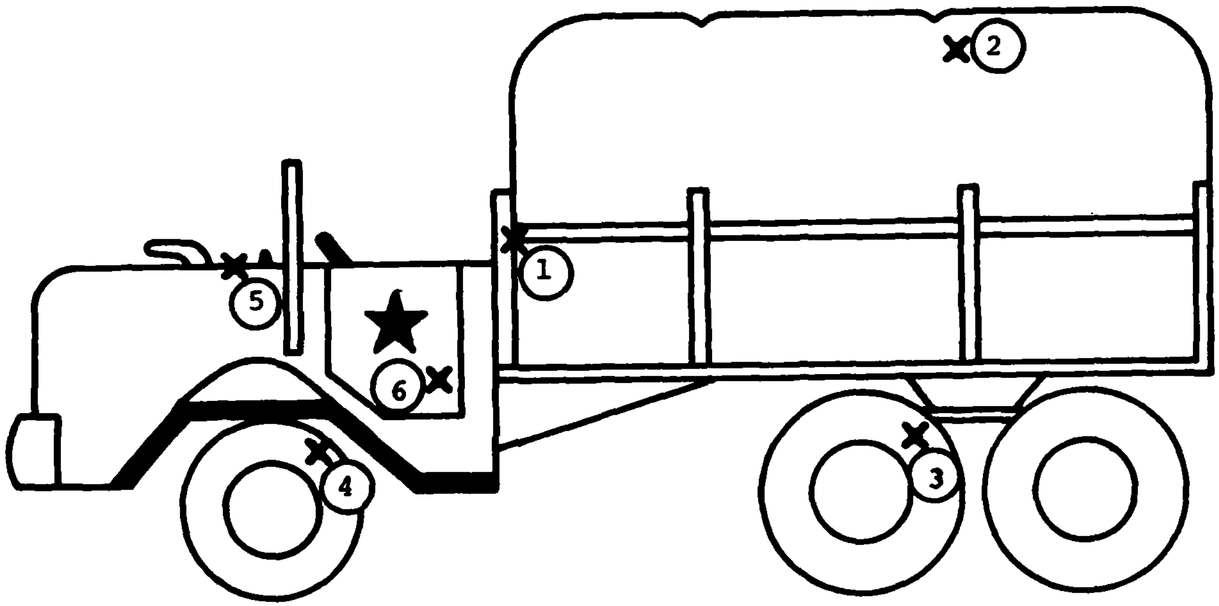


Figure 1-B-2

2-1/2-ton Truck Photometric Points.

APPENDIX 2

ANNEX B

METEOROLOGICAL INSTRUMENTATION AND DATA

1. General. Meteorological support for the project was provided by Det 7, 16 WS, the Ft. Ord Base Weather Station, and the ASL Meteorological Team (ASL-MT) at HLMR. Types of support and instrumentation were as described in reference (b) with the exceptions that a nephelometer was not available for the entire period of operations and the Radient Power Measuring Instrument (RPMI) failed to arrive. The weather at HLMR was generally excellent during the planned operating days and analysis of the data collected during operations does not show values which would be expected to significantly affect the quality of imagery. This makes determination of critical meteorological instrumentation difficult. This section will discuss the instrumentation, procedures, and analysis of IC1 and the problems associated with each.

2. Instrumentation.

a. Standard Surface and Upper Air Instrumentation. All instrumentation was on-site at the commencement of operations and operated successfully throughout the project.

b. Integrating Nephelometer (MRI 1050/2050). The project meteorologist had arranged to borrow primary and back-up units within the services. However, both instruments became unavailable during the week prior to commencement of operations. MAJ Try obtained the use of a third instrument for a limited time through a personal friend; however, it was only available during fixed-wing operations. The model borrowed was not equipped for portable (battery-powered) operations and was located in a shed within the ASL-MT complex. After initial set-up and calibration, it worked very well and required little attention.

c. Sun Photometer (EPA Dual Wavelength). The primary instrument was borrowed from the Environmental Protection Agency (EPA) and a back-up unit from the Air Force Cambridge Research Laboratory (CRL). The EPA unit was located at the ASL-MT site and the CRL unit at the target sites for comparison purposes. Hourly observations were taken on each day of operations. Both instruments worked very well. The EPA instrument is a high quality unit and is the type that should be acquired for future SEEKVAL projects if the RPMI is not employed.

d. Pyranometer. An Eppley pyranometer and recorder was requested from the Army but not received. Two silicon pyranometers (similar to the Eppley) were provided. The recorder was lost in shipment, but arrived on 2 October and was operational at the commencement of operations on 3 October. Both instruments worked well.

e. Radiant Power Measuring Instrument (RPMI/Bendix Corp). This is a portable instrument which performs the functions of a sun photometer, pyranometer, and telephotometer. Arrangements were made to borrow a unit from the Bendix Corporation. This was also lost in shipping and not found until 31 October, thus was not used. The capability of this instrument to perform the functions of three other instruments makes it desirable for use in future SEEKVAL projects.

3. Procedures. General operating procedures are described in reference (b). They were followed except for the following changes.

a. A current altimeter setting was provided to the PM 15 minutes prior to the first run of the day and updated whenever the altimeter setting varied by 0.02 in Hg.

b. Test observations were taken at 30 minute intervals.

c. Upper-air data was not collected during rotary-wing operations.

4. Data Reduction. Tab A to this appendix contains the reduced data tabulated by M/E number. The predominately excellent weather is apparent from the 30 to 50 mile meteorological range values and the consistently CLEAR sky conditions reported. The derivation of the values in Tab A is discussed in the following sections.

a. Meteorological Visual Range (V). V is a quantitative measure of visibility obtained from the nephelometer scattering coefficient (bs) data and Koschmieder's Law, $V = 3.912/bs$, where absorption is assumed to be zero.

b. Turbidity - Total Atmospheric Extinction due to Aerosols (B). Sun photometer data for both .5 and .38 micron wavelengths were plotted on a Langley Plot. The data made it clear that the turbidity changes significantly during the day (higher near noon due to increased activity) and can change significantly within one hour. Single point readings taken near encounter times were used based on the EPA nomogram method. Extreme care should be taken when reading the instrument and several readings should be taken at near the same air mass value (M) (i.e., time space closer together in late afternoon than around noon when M changes more slowly). Fifteen minute readings during M/E times would be appropriate and the need for hourly readings during the day omitted. The Angstrom exponent (d) was computed and did not show any identifiable trends, however, on 26 October and 29 October anomolous scattering conditions prevailed. Values from both wavelengths should continue to be recorded for future projects and the Angstrom exponent computed.

c. IR Transmission (Tr). Tr values in the 8-14 micron region were computed for vertical paths from 0 - 1000 ft and 0 - 3000 ft AGL using the graphs given in "Optical Properties of the Atmosphere (3rd Ed.)", R. McClatchey, et. al., AFCRL 72-0497 (pages 60 and 91).

d. Incoming Solar Radiation (Sr). The incoming solar radiation can be related to illumination level. However, two Eppley pyranometers with WG7:RG8 filters are required to do this accurately. Due to the complexity of data analysis and the requirement for target site monitoring of illumination levels the pyranometer requirement should probably be deleted for future SEEKVAL projects.

e. Other. The remaining data presented in Tab A are taken from the standard surface observations except the inversion top values which come from the radiosonde data. The validity of the sky condition observations can be questioned if the target sites are appreciably distant from the observation site; consideration should be given to the use of all-sky cameras to record the actual sky condition at each target site at the same time as the illumination measurements and fly-over.

f. Satellite Photography. One week (8-12 October) of satellite photography from the military DAPP system was obtained to investigate its usefulness. However, the scale of the photographs was too small to provide significant information and its use in future projects is not recommended.

TAB A

APPENDIX 2

ANNEX B

REDUCED METEOROLOGICAL DATA

1. Variables.

a. Meteorological Visual Range (V) in miles - computed from V = 3.912/bs where bs, the surface extinction coefficient is obtained from nephelometer data.

b. Turbidity (B) - Source: Sun Photometer - total atmospheric extinction coefficient at 0.5 micron. Turbidity is dimensionless.

c. IR transmission (Tr) - Source: Radiosonde - reported in the 8-14 micron region in percent. Data is given for surface-to-1000 feet and surface-to-3000 feet.

d. Incoming solar radiation (Sr) - Source: Pyranometer - reported in the 0.3 - 3.0 micron region in Langleys (lg).

e. Sky conditions - Source: Standard Observation (SO) - reported as total cover tenths - Type - Base altitude in hundreds.

f. Prevailing visibility (Vsby) - Source: SO - reported in miles.

g. Temperature (T) - Source: SO - reported in degrees Fahrenheit.

h. Relative humidity (RH) - Source: SO - reported in percent.

i. Wind - Source: SO - reported in degrees/knots.

j. Inversion top - Source: Radiosonde - reported in feet AGL.

TABLE 2-B-1

REDUCED METEOROLOGICAL DATA

M/E	DTG (PDST)	V (mi)	B	Tr (%) 0-1000	Tr (%) 0-3000	Sr (lg)	Sky Cond.	Vsby (mi)	T (°F)	RH (%)	Wind (deg/kts)	Inversion Top (ft. AGL)
11	03/1214	33	.082	.970	.951	1.14	Clear	>15	77	23	150/03	2800
12	/1216											
13	/1235											
14	/1237					1.48						
31	/1342	50										
32	/1344											
33	/1401					1.10			80	14	070/08	
34	/1403											
41	04/1218	50	.080	.979	.960	1.13	Clear		81	29	180/03	2000
42	/1220											
43	/1237											
44	/1239					1.15						
21	/1316		.090			1.14			86	25	180/04	
22	/1318											
23	/1337											
24	/1339											
51	/1608		.074	.972	.951	0.70			88	25	170/04	3000
52	/1610											
53	/1630		.070			0.59						
54	/1632											

M/E	DTG	V (mi)	B	Tr (%)		Sr (lg)	Sky Cond.	Vsby (mi)	T (°F)	RH (%)	Wind (deg/kts)	Inversion Top (ft. AGL)
				0-1000	0-3000							
82	05/1245	27	.112	.974	.950	1.13	Clear	>15	86	14	120/03	3000
101 (61-64)	/1354	50	.104				2/10 Ci 230 Thin		88	15	140/04	
--	9/1215	50	.078	.965	.933	1.35	7/10 Sc 30		65	49	320/05	3000
21R	10/1217	27	.060	.967	.942	1.10	Clear		68	40	150/04	1000
22R	/1219											
23R	/1247	35	.056			1.11			72	29	140/03	
24R	/1249											
41R	/1417	50	.062				1/10 AC 150 Thin		74	22	270/05	
42R	/1419											
71-74	11/1215 -1330	40	.062	.973	.950	.94-1.14	4/10 Cs 180 Thin		74	24	200/04	3000
81	/1335	45										
102	/1342		.072									
51R	/1558	50	.052	.971	.946	.68	6/10 Cs 180 Thin		76	20	020/05	3000
52R	/1600											
53R	/1621		.048									
54R	/1623					.54						
92	/1640								74	26	350/03	
91	/1655											

M/E	DTG	V (mi)	B	Tr (%) 0-1000	Tr (%) 0-3000	Sr (lg)	Sky Cond.	Vsby (mi)	T (°F)	RH (%)	Wind (deg/kts)	Inversion Top (ft. AGL)
61	12/1250	18-										
62	1330	22	.102	.970	.945	1.54	1/10 Cs 180 Thin		80	24	200/05	1700 &2900
121	17/1600		.044			.65	Clear	>15	82	16	150/04	
122	/1615		.032			.58						
111	18/1200		.072			1.01	4/10 Ci 200 Thin		82	15	130/03	
131	/1205											
113	/1215											
132	/1219											
112	/1236		.068									
114	/1246						2/10 Ci 200 Thin		86	15	100/03	
153	/1254		.070			1.03						
152	/1301											
154	/1345		.072						87	15	130/04	
151	/1357											
161	26/1445		.062				Clear		74	32	050/04	
162	/1505											
171	/1607		.048			.56			74	33	040/03	
172	/1633		.040			.42						

M/E	L	V (mi)	B	Tr (%)		Sr (lg)	Sky Cond.	Vsby (mi)	T (°F)	RH (%)	Wind (deg/kts)	Inversion Top (ft. AGL)
				0-1000	0-3000							
163	30/1[illegible]		.090			.92	Clear	13	68	32	150/03	
182	/1115		.091			.94		12			180/03	
162R	/1137		.089									
181	/1151					.96			71	28	110/04	
164	/1212										190/03	
161R	/1227								76	26		
141	/1302											
142	/1331											

ANNEX C

This annex contains tabulated target data, including contrast, clutter, reflectance, and available range. Also presented is a tabulation of contrast changes versus time.

APPENDIX 1

ANNEX C

TARGET CONTRAST DATA

1. Inherent Contrast. The inherent contrast data presented in this appendix were computed directly from the raw photometric data gathered during project operations. The individual luminance readings for target and background points were averaged to produce mean luminances for both target and background. These were converted into reflectances through the use of 18% gray card data. The resulting reflectances were then used to compute target/background contrast for each vehicle in the array. The two target reflectances were then averaged, as were the background values. These two average values were used to compute total target array contrast.

2. Apparent Contrast. Microdensitometer measurements were performed on selected 70mm imagery to obtain comparison measures of contrast. Two methods of measurements were used on individual 70mm frames extracted near the minimum available range to provide maximum target size for the study.

a. Single-Spot. A 16 micron scanning aperture was used to obtain one density measurement at a "representative" brightness level on each vehicle and four density measurements of the background area. Background measurements were taken at points above, below, and to either side of each vehicle at a distance of approximately one vehicle length from the center. The resulting densities were converted into percent transmittance and a mean background transmittance computed. These were used to compute contrast values for each vehicle. The individual contrast values were then averaged to produce a total target array contrast. This method proved less than satisfactory in some cases due to the relatively small spot size; it was possible to change the contrast values appreciably simply by scanning a different portion of the vehicle. For this reason, a different procedure was developed which provided better results.

b. Multiple-Spot. A larger (46 micron) spot was used in a scanning procedure similar to the photometric procedures used in the rotary-wing phase of the project. Several points on each vehicle were scanned and combined to yield an average transmittance for each vehicle. Background data was obtained as before, but with the larger spot. The density data was processed as in the single-spot procedure. This method pro-duced results which were in much closer agreement with the inherent contrast figures.

Table 1-C-1

Target Contrast Data

M/E	DTG (local)	Tgt Loc (UTM)	Inherent Contrast West	East	Total	Apparent Contrast West	East	Total
11	031214	644882	-.05	-.36	-.23	-.23	-.01	-.11
12	031216	645798	-.32	-.58	-.48	-.44	-.66	-.55
13	031235	644882	-.05	-.36	-.23			
14	031237	645798	-.32	-.58	-.48			
21	041316	648880	-.70	-.81	-.76	-.83	-.73	-.78
22	041318	661805	-.56	-.60	-.58	-.70	-.60	-.65
21R	101217	648880	-.59	-.67	-.63	-.68	-.54	-.61
22R	101219	661805	-.34	-.59	-.48	-.76	-.52	-.64
23	041337	648880	-.70	-.81	-.76			
24	041339	661805	-.56	-.60	-.58			
23R	101247	648880	-.59	-.67	-.63			
24R	101249	661805	-.34	-.59	-.48			
31	031342	644882	-.05	-.36	-.23	-.55	-.79	-.67
32	031344	645798	-.32	-.58	-.48	-.77	-.81	-.79
33	031401	644882	-.05	-.36	-.23			
34	031403	645798	-.32	-.58	-.48			
41	041218	648880	-.70	-.81	-.76	-.80	-.75	-.78
42	041220	661805	-.56	-.60	-.58	-.73	-.37	-.55
41R	101417	648880	-.59	-.67	-.65	-.84	----	-.84
42R	101419	661805	-.34	-.59	-.50	-.85	-.66	-.75
43	041237	648880	-.70	-.81	-.76			
44	041239	661805	-.56	-.60	-.58			

Target Contrast Data

M/E	DTG (Local)	Tgt Loc (UTM)	Inherent Contrast West	Inherent Contrast East	Inherent Contrast Total	Apparent Contrast West	Apparent Contrast East	Apparent Contrast Total
51	041608	648880	-.75	-.80	-.78	-.93	-.85	-.89
52	041610	645798	-.41	-.63	-.52	-.75	-.66	-.71
51R	111558	648880	-.59	-.67	-.64	-.77	-.85	-.81
52R	111600	645798	-.23	-.66	-.51	-.60	-.36	-.48
53	041630	648880	-.75	-.80	-.78			
54	041632	645798	-.41	-.63	-.52			
53R	111621	648880	-.76	-.67	-.71			
54R	111623	645798	-.23	-.66	-.51			
81	111335	644882	-.10	--	--	-.50	-.70	-.60
82	051245	648880	-.54	-.60	-.56	-.80	-.84	-.82
91	111655	648880	-.59	-.67	-.64	-.86	--	-.86
92	111640	645798	-.23	-.66	-.51	-.34	-.73	-.53
101	051354	661805	-.54	-.60	-.56	-.54	-.75	-.65
102	111342	645798	-.52	-.30	-.42	-.60	-.26	-.43
111	181200	646868	-.50	-.55	-.53	-.78	-.72	-.75
112	181236	644868	-.55	-.43	-.49	-.64	-.68	-.66
113	181215	638800	-.53	-.29	-.42	-.70	-.78	-.74
114	181246	639800	-.38	-.47	-.43	-.88	-.72	-.80
121	171600	646868	-.53	-.59	-.56	-.76	-.67	-.71
122	171615	638800	-.46	-.28	-.37	-.75	-.76	-.75

Target Contrast Data

M/E	DTG (Local)	Tgt Loc (UTM)	Inherent Contrast West	Inherent Contrast East	Inherent Contrast Total	Apparent Contrast West	Apparent Contrast East	Apparent Contrast Total
131	181205	646868	-.50	-.55	-.53	-.82	-.81	-.81
132	181219	638800	-.53	-.29	-.42	-.77	-.87	-.83
141	301302	638800	-.19	-.62	-.46	-.45	-.74	-.60
142	301331	Res tgt			-.96			
151	181357	648880	-.56	-.61	-.59			
152	181301	644882	-.64	-.64	-.64	-.54	-.55	-.54
153	181254	639800	-.38	-.47	-.43			
154	181345	638800	-.46	-.39	-.43			
161	261445	644882	-.35	-.50	-.43	-.38	-.71	-.54
161R	301227	644882	-.49	-.52	-.51	-.78	-.75	-.76
162	261505	647878	N/R	N/R	N/R			
162R	301137	647878	-.66	-.68	-.67	-.91	-.93	-.92
163	301100	644878	-.54	-.45	-.50	-.82	-.86	-.84
164	301212	646880	-.57	N/R	N/R	-.91	-.92	-.92
171	261633	647878	-.50	-.63	-.57	-.95	-.94	-.94
172	261607	644878	-.57	-.50	-.54	-.64	-.67	-.66
181	301151	647878	-.66	-.68	-.67	-.92	-.90	-.91
182	301115	644878	-.54	-.45	-.50	-.88	-.84	-.86

Notes:

a. M/E 31. Apparent contrast value very uncertain due to extreme slant range (ca. 3300').

b. M/E 113. Apparent contrast measurement did not include trees in background - omitting trees from photometer data gives values of: -.70/-.56/-.63/Δ+.19.

c. M/E 181. Photometer data included tree shadows in background.

d. M/E 51R. West vehicle has appreciable tree shadow as part of background - omitting shadow from photometer data gives: -.76/-.67/-.71.

APPENDIX 2

ANNEX C

TARGET CONTRAST VERSUS TIME

1. General. This data provides information relative to the variations in target/background contrast during the period of project operations. It should be noted that only those locations which were used over a relatively long period of time are listed.

2. Specific. Contrast values for most locations varied little throughout the project. The single location whose background was composed of growing vegatation (grass) had the largest variation due to the grass being flattened by vehicular movement during the project and eaten and trampled by cattle in the area. This was the area at 644882.

TABLE 2-C-1

TARGET CONTRAST VERSUS TIME

Tgt Loc 644882 - LN		
M/E	DTG	Contrast
11	031214	-.23
13	031235	-.23
31	031342	-.23
33	031401	-.23
81	111335	--
152	181301	-.64
161	261445	-.43
161R	301227	-.51

Tgt Loc 645798 - HN		
M/E	DTG	Contrast
12	031216	-.48
14	031237	-.48
32	031344	-.48
34	031403	-.48
52	041610	-.52
54	041632	-.52
102	111342	-.42
52R	111600	-.51
54R	111623	-.51
92	111640	-.51

Tgt Loc 638800 - HN		
M/E	DTG	Contrast
122	171615	-.35
113	181215	-.45
132	181219	-.42
154	181345	-.43
141	301302	-.46

Tgt Loc 648880 - LM		
M/E	DTG	Contrast
41	041218	-.76
43	041237	-.76
21	041316	-.76
23	041337	-.76
51	041608	-.78
53	041630	-.78
82	051245	-.56
21R	101217	-.63
23R	101247	-.63
41R	101417	-.65
51R	111558	-.64
53R	111621	-.71
91	111655	-.64
151	181357	-.59

Tgt Loc 661805 - HM		
M/E	DTG	Contrast
42	041220	-.58
44	041239	-.58
22	041318	-.58
24	041339	-.58
101	051354	-.56
22R	101219	-.48
24R	101249	-.48
42R	101419	-.50

APPENDIX 3

ANNEX C

CLUTTER DATA

1. This section contains the actual number of trees within 200 meters of each target location. The data was obtained from the 1:3000 aerial mosaic discussed in Annex E.

TABLE 3-C-1

CLUTTER DATA

Target Location	Trees	Remarks
Fixed-Wing		
644882	25	2 trees East of hwy, 23 West
647880	52*	
661805	38	
644798	20	All trees in river bed West
Rotary-Wing		
644878	12	2 trees East of hwy, 10 West
646880	26	All trees East
647880	52*	
646868	104*	All trees on hills East
645868	14	All trees near hwy West
639797	7	
640797	53*	All trees in river bed
644882	25	2 trees East of hwy, 23 West

* Approximate due to number of small trees

APPENDIX 4

ANNEX C

AVAILABLE RANGE

This section presents data on ranges and times of target availability. The data was produced by BAC and indicates the distance (or time for rotary-wing pop-up) that the target array is available for detection.

TABLE 4-C-1

AVAILABLE RANGES

(Fixed-wing)

M/E	Range (ft)	M/E	Range (ft)
11	2817	41R	4846
12	10264	42R	5437
13	4905	43	9515
14	10185	44	7762
21	6225	51	6225
22	4590	52	10959
21R	4886	51R	6166
22R	4295	52R	10855
23	11564	53	9495
24	9555	54	14125
23R	7978	53R	9200
24R	6580	54R	9082
31	2837	81	5247
32	8274	82	4369
33	--	91	6621
34	9101	92	11214
41	6225	101	10561
42	5693	102	10899

TABLE 4-C-2

AVAILABLE TIMES

(Rotary-wing Pop-up)

M/E	Time (sec)	M/E	Time (sec)
11	50.5	131	52.4
112	55.9	132	58.9
113	51.0	151	52.5
114	53.6	152	54.4
121	50.9	153	64.7
122	53.2	154	57.3

TABLE 4-C-3

AVAILABLE RANGES

(Rotary-wing NOE)

M/E	Range (ft)	M/E	Range (ft)
161	4223	171	1357
162	--	172	2951
161R	2564	181	2256
162R	2047	182	2412
163	2574		
164	2493		

APPENDIX 5

ANNEX C

VEHICLE REFLECTANCES

These data are the average reflectances of the target vehicles used in the project. They were obtained from the raw photometric data taken during project operations. It should be noted that the M-60 value is about 15% higher than would be expected. This is probably due to the fact that one tank was painted with a semi-gloss paint instead of the normal flat paint, thus giving a higher value of reflectance.

TABLE 5-C-1

VEHICLE REFLECTANCES

Vehicle Type	Phase		Mean
	Fixed-Wing	Rotary-Wing	
2-1/2-ton Truck	0.077	0.072	0.075
M-60 Tank	0.088	0.095	0.092

ANNEX D

FLIGHT DATA

This annex contains a statistical summary of project operations and a tabulation of fixed-wing offsets.

TABLE D-1

OPERATIONAL SUMMARY

	70mm Footage	Aircraft Hours	70mm Total Encounters	Retakes	IR Encounters
Production Runs					
Fixed-Wing	12,000	29.9 (B-25)	43	10 (1)	32 (3)
Rotary-Wing PU	3,000	2.4 (UH-1H)	12	0	---
Rotary-Wing NOE	7,000	4.0 (AH-1G)	13	2 (2)	---
Misc. (Test, Ferry, Aborts, Min, Day, etc.)	5,000	20.1 (All)	--	---	---
Total	27,000	45.0	68	12	32
Difference From Planned	-10%	-10%	+13%	-29%	+128%

Calendar Dates:	Scheduled	Actual	Flying Days
Fixed-Wing	Oct 1-24	Oct 1-16	11
Rotary-Wing	Oct 22-Nov 2	Oct 16-30	4

Notes:

(1) Planned retakes due to offset error (4), target anomalies (4), weather (1), and camera jam (1).
(2) Planned retakes due to time constraints.
(3) Two encounters of each planned condition were completed.

APPENDIX 1

ANNEX D

FIXED-WING OFFSETS

1. These data were taken from the overlay plots produced by the HLMR M-33 radar described in reference (c). The data were used during the project to ensure that pre-planned offset parameters were being met. Retakes were scheduled if the following conditions existed:

a. Both M/E's on a run had offset errors greater than 50%, or,

b. One M/E had an offset error greater than 75%.

TABLE 1-D-1

FLIGHT TRACK OFFSET DATA

(Fixed-Wing Only)
(All data derived from M-33 radar plots)

M/E	DTG (Local)	Tgt Loc (UTM)	Offset (ft) Desired	Offset (ft) Actual	Track Δ (ft)	% Error
11	031214	644882	500	738	+238	48
12	031216	645798	500	164	-336	67
13	031235	644882	500	574	+74	15
14	031237	645798	500	164 (1)	+664	133
13R	111317	644882	500	656	+156	31
14R	111319	645798	500	722	+222	44
21	041316	648880	500	902	+402	80
22	041318	661805	500	1312	+812	162
21R	101217	648880	500	410	-90	18
22R	101219	661805	500	820	+320	64
23	041337	648880	500	1312	+812	162
24	041339	661805	500	2625	+2125	425
23R	101247	648880	500	361	-139	29
24R	101249	661805	500	689	+189	38
23R	121256	648880	500	591	+91	18
24R	121258	661805	500	755	+255	51
31	031342	644882	1500	2461	+961	64
32	031344	645798	1500	1969	+469	31
33	031401	644882	1500	1312	-188	13
34	031403	645798	1500	1476	-24	2
41	041218	648880	1500	2461	+961	64
42	041220	661805	1500	820	-688	45
41R	101417	648880	1500	1608	+108	7
42R	101419	661805	1500	2001	+501	33
43	041237	648880	1500	1476	-24	2
44	041239	661805	1500	2625	+1125	75

Note: (1) Actual track on opposite side of target than planned.

M/E	DTG (Local)	Tgt Loc (UTM)	Offset (ft) Desired	Offset (ft) Actual	Track Δ (ft)	% Error
51	041608	648880	500	492	-8	2
52	101610	645798	500	656	+156	31
51R	111558	648880	500	591	+91	18
52R	111600	645798	500	623	+123	25
53	041630	648880	500	0	-500	100
54	041632	645798	500	820	+320	64
53R	111621	648880	500	755	+255	51
54R	111623	645798	500	722	+222	44
61	051334	648880	500	443	-57	11
62	051336	661805	500	1394	+894	179
61R	121317	648880	500	656	+156	31
62R	121319	661805	500	656	+156	31
63	051216	648880	500	492 (1)	+992	198
64	051218	661805	500	2543	+2043	409
63R	121216	648880	500	328	-172	34
64R	121218	661805	500	394	-106	21
71	091324	644882	500	427	-73	15
72	091326	645798	500	886	+386	77
71R	111412	644882	500	558	+58	12
72R	111414	645798	500	656	+156	31
73	091224	644882	500	558	+58	12
74	091226	645798	500	787	+287	57
73R	111208	644882	500	722	+222	44
74R	111210	645798	500	623	+123	25
81	111335	644882	0	82	82	
82	051245	648880	0	82	82	
91	111655	648880	0	0	0	
92	111640	645798	0	164	164	
101	051354	661805	0	492	492	
102	111342	645798	0	164	164	

Note: (1) Actual track on opposite side of target than planned.

ANNEX E

PROJECT IC1 INTERIM REPORT

1. This annex contains the Project Interim Report, printed in its entirety for information purposes. It should be noted that, due to additional information which has become available, some conclusions and recommendations may have been modified. Where this is the case, the modified information is contained in the applicable sections of this report.

2. Conclusions which have been modified are numbers 1, 2, 4, 9, and 12.

3. Recommendations which have been modified are numbers 1, 2, 3, and 8.

DEPARTMENT OF THE NAVY
AIR TEST AND EVALUATION SQUADRON FIVE
NAVAL AIR FACILITY
CHINA LAKE, CALIFORNIA 93555

21/WWM:wr
3930

From: Project Manager, SEEKVAL Project IC1
To: Joint Test Director, Project SEEKVAL

Subj: Project IC1 interim report; submission of

Ref: (a) SEEKVAL Project IC1 Plan
(b) USAFTAWC Manual 55-1
(c) SEEKVAL Phase I Plan
(d) SEEKVAL Project IC1 Test Directive

Encl: (1) Target Array Locations
(2) Personnel Requirements
(3) Rotary-wing Photometric Procedures
(4) Radio Net Descriptions
(5) Radar System Description

1. Background. Reference (a) requires that an interim report be submitted covering the operational portion of Project IC1. Reference (b) provides only limited information on the content and format of interim reports, but specifies that they are normally submitted by letter or message. This letter is intended to serve as the required interim report for Project IC1.

2. Purpose. This report is written to provide lessons learned to the designers of Project IC2 and information on long lead-time requirements for that project. For this reason, it will cover only the applicable portions of the report format detailed in reference (c). Specifically it assumes familiarity with sections 1 and 2 of that format and will discuss the remaining sections only as they pertain to operational methods and results.

3. Method of Accomplishment

a. Target Array Location. Target arrays were located to fulfill the requirements set forth in reference (d) for clutter and contrast. The Project Manager (PM) made a personal reconnaissance of the operating area to obtain rough photometric measurements of the various backgrounds available.

These and 35mm color slides were used to determine target array locations that would provide the desired target/background contrast and clutter levels. Each vehicle location was marked with a cairn of stones and the target array centroid was surveyed using the M-33 radar later used in the project and a beacon-equipped helicopter hovering over each site. Target array locations in Universal Transverse Mercator (UTM) coordinates are provided in enclosure (1). Although coordinates are listed to the nearest meter, system accuracy, although unverified, is probably no more than ±30 meters. Two alternate methods of target array location were investigated.

(1) A map study was made using 1:25,000 scale photomaps and orthophotomaps. These enabled location to within ±12 meters, the relative accuracy of the map itself.

(2) An uncontrolled mosaic was flown and printed by VFP-63, a USN photographic squadron based at NAS Miramar, California. Although, due to technical problems, it arrived at Ft. Ord too late to be used in the actual location process, subsequent study demonstrated its value in a mock determination. The requested scale was "about 1:3000"; the actual scale was 1:2969.

b. Ground Operations

(1) General. A detailed briefing was conducted by the Experimental Control Officer (ECO) at 0745 each morning of scheduled operations. Attendees at this briefing were:

(a) Target array NCOIC's

(b) Photometer team leaders

(c) Radar controller (during fixed-wing operations only)

(d) Crash-rescue OIC

(e) Experimental Control Center (ECC) NCOIC

General subjects covered at this briefing included target array positions and moves, time schedules, and encounters scheduled. Specific subjects, e.g., photometer readings, were covered with personnel concerned. Following this briefing, personnel were released to perform their specific duties. Enclosure (2) contains a detailed list of personnel requirements.

(2) Specific Target Procedures

(a) Vehicle Positioning. Target vehicles were normally positioned in a column perpendicular to the aircraft flight path with 100' spacing. Vehicle positioning was the responsibility of the target array NCOIC. Targets were normally in position 1 to 1-1/2 hours prior to initial TOT. When scheduled as a "hot" IR target, vehicles were driven in the local area for 30 minutes and moved into final position 15 - 20 minutes prior to the scheduled TOT.

(b) Vehicle Cleanliness. To provide a constant reflectivity for 70mm photography, vehicles were washed prior to leaving the motor pool and, in the case of the tank targets, again when they were in their designated positions. It was not considered necessary to wash the truck targets since they traveled on hard-surface roads to within about 300 meters of their final locations.

(c) Air Operations

1. Fixed-wing. The B-25 crew was briefed by the PM regarding the desired sequence of production runs and the tracks and target locations to be used. The crew normally consisted of six persons; pilot, co-pilot, flight engineer, flight director (normally the Boeing PM), and operators for the 70mm camera and the AN/AAS-27/frame camera systems. The aircraft launched from Monterey Airport 30-45 minutes prior to the initial TOT and flew to the vicinity of the track IP where radar and radio contact was established and the briefed sequence of practice/production runs was commenced. During the initial phases, radar vectoring was used only on practice runs; however, it was determined that some required flight parameters could not be adequately reproduced without the aid of radar and vectoring was utilized on all runs during the later stages of fixed-wing operations.

2. Rotary-wing. The two rotary-wing aircraft were based at Hunter Liggett for project flights. The crew for the UH-1H used in the pop-up encounters consisted of five persons; pilot, co-pilot, crew chief, flight director, and camera operator. The AH-1G crew consisted only of the pilot and camera operator with the flight director flying with the ECO and PM in an OH-58. Crew briefing was similar to that of the fixed-wing crew. Conduct of the flight was also similar, except that, due to the altitudes and terrain involved, radar tracking was not possible.

(d) Photometric Procedures

1. Fixed-wing. Photometric procedures were performed as detailed in reference (a).

2. Rotary-wing. Due to the very flat viewing angle in the rotary-wing phase of operations, it was decided to alter the method of obtaining photometric data for rotary-wing filming. The method is described fully in enclosure (3).

(e) Film Processing

1. 70mm. At the end of each flight, a short (2-3 feet) length of 70mm film was clipped from the last exposed roll for QLP (Quick-Look Processing). This was done to verify proper mechanical operation of the camera and was not intended to provide data on other facets of the collection procedure. The film was hand-processed at the USACDEC photo lab using black-and-white processing chemistry and techniques. The film was inspected by the Boeing PM and camera man prior to completion of planning for the next days operation.

2. IR and Frame. QLP of IR and frame camera imagery was also performed after each mission on which the particular equipment was used. Since this was black-and-white film, the processed negatives could be, and were, inspected for image quality as well as proper mechanical functioning.

(f) Command and Control (C and C)

1. Authority. Although the PM exercised overall C and C authority, that authority was delegated to the ECO and the flight director in matters relating to their specialties. The ECO further delegated authority to the target array NCOIC's in matters pertaining to their individual array.

2. Conduct. During all missions, both fixed and rotary-wing, the ECO was airborne in an OH-58 to exercise overall control and direction. The PM flew with the ECO when possible and, during the rotary-wing NOE phase, the flight director was also aboard. The OH-58 provided the mobility to enable the PM and ECO to coordinate the activities at both target locations nearly simultaneously, a necessity when target locations were changed between runs.

3. Communications. Two radio nets were used during the conduct of operations. An FM net was used to control target placement and activities and was the primary air-to-ground net. The UHF net was used for air-to-air communications and for radar control of the B-25 during fixed-wing operations. Enclosure (4) contains the details of both nets.

4. Results and Discussion

a. Target Array Location

(1) General. The locations picked by the PM proved to be satisfactory for the most part. Several deficiencies became evident during the course of the project, however, that may impact upon the test design for IC2. Specifically, these are concerned with target/background contrast levels and with the differing effects of clutter in fixed and rotary-wing environments.

(a) Contrast. Photometric data taken during the planning phase of the project indicated that sufficient differences existed in the background reflectances of the chosen locations to provide the desired levels of target/background contrast. Planning was therefore completed using these locations. Subsequent to the completion of planning and the commencement of operations, however, environmental factors were sufficient to change one location from low contrast to high contrast. Specifically, the grass ashes which made up the dark background of location 6476387967 were dispersed by wind, rain, and traffic to the point where the area was virtually bare and produced a high contrast value. A second area of lush green grass which was a low contrast area at the commencement of project operations was eaten and trampled by a herd of cattle until it was appreciably lighter in color and higher in contrast.

(b) Clutter

1. Fixed-wing. Although there were no major problems with clutter becoming masking during fixed-wing operations, one target array was placed so that for a 500 foot offset flight track, both vehicles were masked earlier than desired. This early masking was not evident in the 1500 foot offset case and is not expected to cause problems in the simulator.

2. Rotary-wing. There were several problems in rotary-wing operations with clutter becoming masking because of the low LOS angles employed. These were solved by emplacing the target vehicles in front of the masking vegetation, thus making the clutter elements background instead of surround.

(c) Location Methodology. The primary method used for target array location proved generally adequate, however, there were two short-comings to the method:

1. Insufficient 35mm slides were taken to cover the entire area. This did not impair the planning process as such, but may have resulted in less than optimum target locations being chosen.

2. Target locations were not flight checked prior to commencement of flight operations. This was done purposely to enable a judgement of the value of flight checking locations. For the fixed-wing operations, it produced no major problems, but for rotary-wing operations it quickly became evident that flight checking each location prior to use was a necessity to preclude unwanted vegetation masking.

b. Ground Operation

(1) General. The movement and placement of target vehicles presented no problems due to the thorough pre-mission briefing given the target array NCOIC's. Vehicles were in place on time for every scheduled mission, and, where it was necessary to change their position between runs, were moved and re-emplaced very rapidly.

(2) Vehicle Cleanliness. Although considered necessary for 70mm filming, it was recognized that the field wash-downs did change the vehicles IR signature. For this reason, no wash-downs were performed when the scheduled mission was solely IR. Wash-downs were performed with the vehicles in their final location. Due to the atmospheric conditions and time involved the resulting ground watermark was not visible by the time production runs were commenced.

c. Air Operations

(1) Fixed-wing. Fixed wing flight tracks were laid out to provide pre-determined offset distances from each target array. Target array location dictated two types of level flight tracks, straight and zig-zag. It was found that the B-25 pilot could reproduce his path along the straight track with reasonable accuracy without radar assistance once he had determined the desired track with radar assistance. However, accurate reproduction of the zig-zag track was not possible without radar vectoring. A detailed description of the radar system used is contained in enclosure (5).

(2) Rotary-wing. The CH-47 scheduled to be used for the rotary-wing portion of the project proved unsuitable due to heat from the engine exhausts being blown into the camera

field of view producing shimmer which degraded the viewing conditions considerably. While other helicopters of similar configuration (CH-46, CH-53) were being investigated, the 70mm camera/Tyler mount system were installed in the cargo compartment of a UH-1H helicopter shooting out the left side. This combination was used to successfully complete the rotary-wing pop-up requirements. Rotary-wing NOE requirements were successfully fulfilled by mounting the 70mm camera on a pedestal mount in the forward battery compartment of an AH-1G. The camera was modified in the field to operate in a normal (forward) direction and was mounted facing forward. The aircraft was flown at 40 KIAS instead of the planned 50 KIAS. The camera framing rate was reduced to 20 frames per second to maintain the planned dynamic range in playback. The anticipated problem of insect impacts on the lens did not materialize; during approximately one and one - half hours at NOE flight conditions, only four impacts were recorded, all by very small insects. Several pop-up maneuvers were performed for comparison with the UH-1H installation. Post-flight comments by the camera operator indicated that the AH-1G was much more stable than the UH-1H and should produce better results. A point of minor concern was the fact that both the UH-1H and AH-1G were single-engine aircraft with very limited capability in the event of engine failure at the flight conditions used in the project.

d. Photometric Procedures. The photometric procedures used in both fixed and rotary-wing phases of the project appear to have given satisfactory results, however, due to the time requirements for one set of data, the rotary-wing procedures appear more suitable if it can be determined that the requisite accuracy can be obtained.

e. Film Processing

(1) 70mm. While the QLP of the 70mm film did not provide useable imagery for on-the-spot quality evaluation, it did confirm proper mechanical operation of the system.

(2) IR and Frame. QLP of both the IR and frame camera systems disclosed operational problems which otherwise would have gone undetected.

(a) IR. QLP of the IR film taken on 8 October disclosed large areas of the film which had not been exposed. Field trouble-shooting disclosed that moisture which had condensed in the system was the cause of the problem. Operating procedures were changed to provide a longer warm-up time prior to production runs and this eliminated the problem.

(b) Frame Camera. QLP of the vertical frame camera run of 4 October 1973 disclosed a pin-hole light leak in the shutter curtain which caused a fog streak on the film during the transport phase. Close inspection revealed numerous other small holes, all of which were patched with magnetic tape foil.

f. Command and Control

(1) General. The major areas of concern in the command and control problem are:

(a) Non-exercise road traffic, and

(b) Communications problems with the B-25.

While the traffic problem at HLMR may not exist at Fort Riley and may not be a factor in simulation, thought should be given to some form of traffic control to make the situation as realistic as possible. The communications problem with the B-25 stems from two causes, mutual uncertainty concerning the schedule of events and the B-25 radio/ICS system. While it is recognized that there may be good reasons for deviating from the planned schedule, it should be followed as closely as possible and all concerned parties must be made aware of any deviations as they occur. The problems with the B-25 system are probably insoluble since they would require completely re-wiring the aircraft. However, they are not severe as long as non-essential radio traffic is minimized during a production run.

(2) Command and Control Helicopter. The OH-58 helicopter used by the ECO and PM proved an invaluable asset to the command and control problem. The mobility and communications capability provided by the aircraft enabled instant decisions to be made regarding target placement and movement, reliable communications with both target array NCO's, and other command and control functions.

5. Conclusions and Recommendations

a. Conclusions

(1) It is very difficult to maintain a pre-planned level of background reflectivity, hence target/background contrast, over a long period of time.

(2) Target array location should be a four-step process:

(a) Personal reconnaissance of the exercise area by the person responsible for target location.

(b) Target array placement using a large-scale aerial mosaic.

(c) Target array coordinate determination using 1:25,000 photomaps or orthophotomaps.

(d) Target array flight-check with vehicles in place using the same flight conditions that will be used in production.

(3) The requested aerial mosaic scale is larger than necessary. A scale of 1:10,000 would have been adequate to fulfill the requirements.

(4) Target locations must be very carefully selected for rotary-wing filming to avoid vegetation masking.

(5) It is feasible to conduct planned target array location changes between production runs.

(6) The requirement for a constant reflectivity for 70mm filming must be balanced against IR requirements.

(7) Field wash-downs are feasible with vehicles in their final positions.

(8) Continuous radar vectors are necessary to accurately reproduce non-linear fixed-wing flight tracks.

(9) It appears feasible to perform both pop-up and NOE rotary-wing filming using a forward-firing camera installation on an AH-1.

(10) Insect impacts on the 70mm lens did not present a problem at HLMR in the rotary-wing environment.

(11) From a safety-of-flight standpoint, a single-engine aircraft is marginal at the flight conditions of this project.

(12) Photometric procedures used for the fixed-wing phase were too time-consuming.

(13) Quick-look processing facilities adjacent to the aircrafts base are essential for early analysis of all imagery.

(14) Non-exercise road traffic should be controlled.

(15) A dedicated command and control helicopter is essential.

b. Recommendations

(1) Do not make target/background contrast a controlled variable.

(2) Task USN/USAF to produce an uncontrolled 1:10,000 aerial mosaic of the exercise area.

(3) Flight check all target array locations prior to commencing any production runs.

(4) Provide a radar tracking unit with capabilities similar to the ones of the M-33.

(5) Initiate a study into the relative insect populations of Ft. Riley and Hunter-Liggett.

(6) Obtain a USMC AH-1J to use in rotary-wing filming.

(7) Ensure that facilities suitable for QLP of all imagery are available at Ft. Riley.

(8) Develop photometric procedures which are less time-consuming.

W. W. MONK
LCDR, USN

AD-A145 287 JOINT TEST PROJECT PLAN OF COMBAT AIR SUPPORT TARGET ACQUISITION PROGRAM. (U) SEEKVAL JOINT TEST FORCE WASHINGTON DC W W MONK MAR 74

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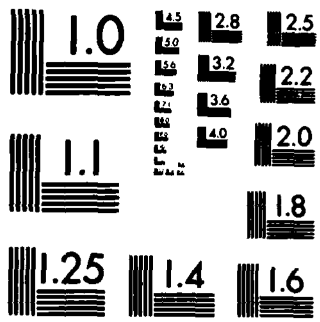


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Target Array Locations

Fixed-wing

Contrast/Clutter	Location
Low/None	10SFQ6437588228
Low/Moderate	10SFQ6476387967
High/None	10SFQ6450079781
High/Moderate	10SFQ6608080460

Rotary-wing Pop-up

Contrast/Clutter/Range (km)	Location
Low/None/1	10SFQ6442486846
Low/Moderate/1	10SFQ6456086842
High/None/1	10SFQ6380580044
High/Moderate/1	10SFQ6390880043
Low/None/2	10SFQ6437588228
Low/Moderate/2	10SFQ6476387967
High/None/2	10SFQ6443887891
High/Moderate/2	10SFQ6452387994

Rotary-wing Nap-of-the-Earth

Contrast/Clutter	Location
Low/None	10SFQ6437588228
Low/Moderate	10SFQ6476387967
High/None	10SFQ6443887891
High/Moderate	10SFQ6452387994

Enclosure (1)

Personnel Requirements

Command/Control and Logistics

Officers

Project Manager (0-4)
Experimental Control Officer (0-4)
Administrative Officer (0-1/2)
Logistics Officer (0-1/2)

Enlisted

Operations NCO (E-7)
Experimental Control NCO (E-6/7)
Administrative NCO (E-5)
Logistics NCO (E-5)

Civilian

Contractor Project Manager
Secretary

Target Array Personnel

Enlisted

Target Array NCOIC (E-5)
Target Vehicle Crews (as required)
1/4-tone Truck Driver for NCOIC

Photometer Crew

Officer

Officer-in-Charge (0-1/2)

Enlisted

Crew NCOIC (E-4/5)
Operator (E-3/4)
Data Recorder (E-3/4)
Vehicle Driver (as required)

Crash-Rescue Crew

Officer

Officer-in-Charge (0-1/2)

Enlisted

As required by local SOP

Enclosure (2)

Miscellaneous Support

Officer

Helicopter Pilot (Command and control aircraft)

Enlisted

Radar Controller
Administrative vehicle drivers

Note: These requirements do not include flightcrews or sensor operators for the filming aircraft.

Rotary-wing Photometric Procedures

1. General. Because of the low LOS angle of the rotary-wing environment, a change was made to the photometric procedures detailed in reference (a). The altered procedures resulted in two advantages over the fixed-wing procedures:

a. Fewer, but larger spot readings were taken providing automatic integration over the various textures and reflectances of each vehicle type.

b. Due to the geometry used, it was feasible to mount the photometer on a tripod and obtain all readings from the same point, producing a significant savings in time required for each set of data.

2. Background Procedures. Three background readings were taken around each vehicle in the target array. The photometer was tripod-mounted at a distance of 250 feet from each vehicle and all readings were taken from that spot. The location of the background spots is shown in Figures 1 and 2.

3. Target Vehicles. Target vehicle readings were taken from the areas shown in Figures 1 and 2. For the M-60 tank, two readings were taken, one before and one after the background data. For the 2-1/2-tone truck, only one set (3 points) of data was taken from each vehicle.

4. Reference Data. To obtain a measure of illumination levels, an 18% grey card was used. Photometer readings were taken of this card as the first and last data points of each set.

5. Data Form. The form used to record rotary-wing photometric data is depicted as Figure 3.

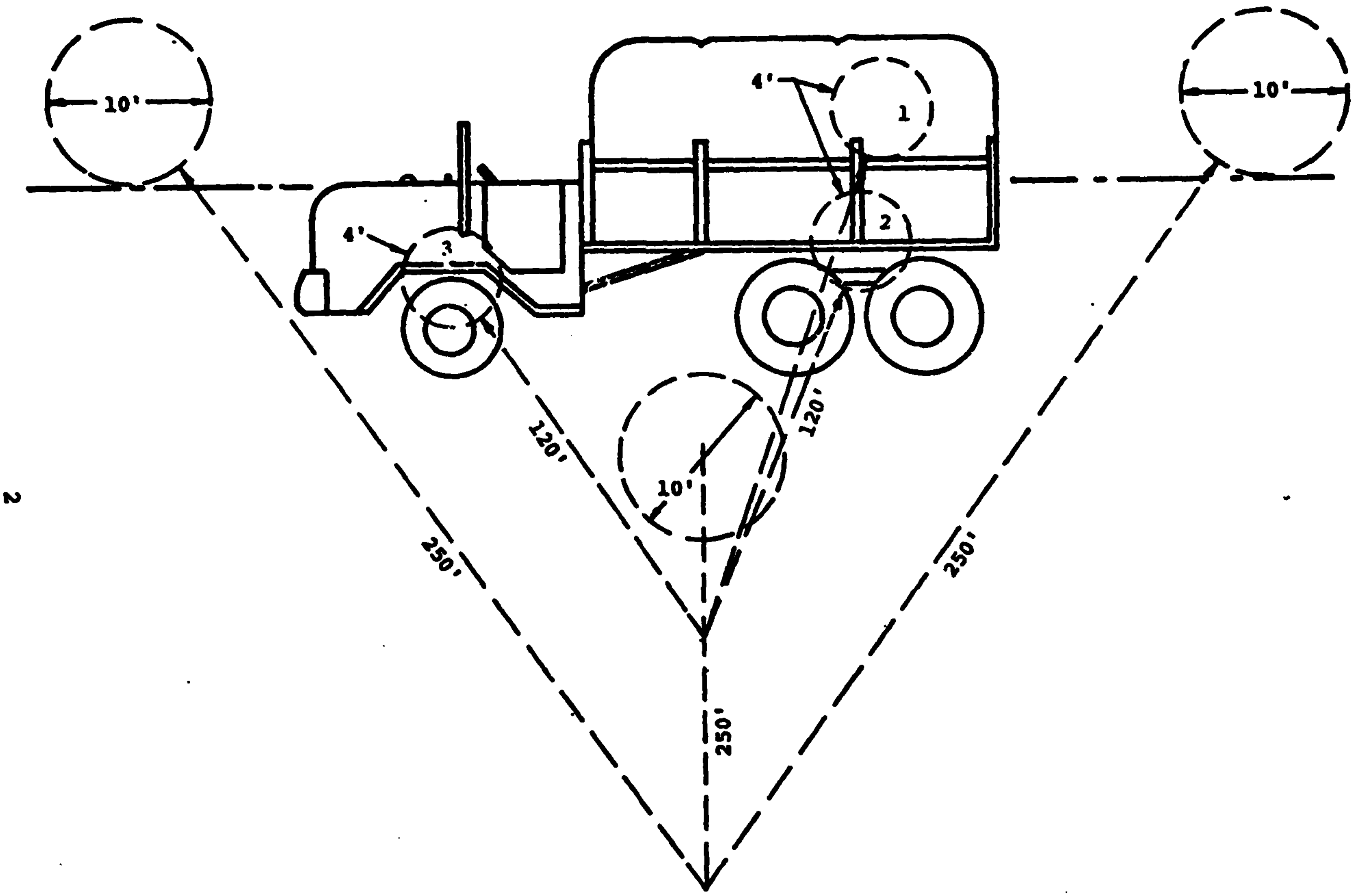


FIG 1

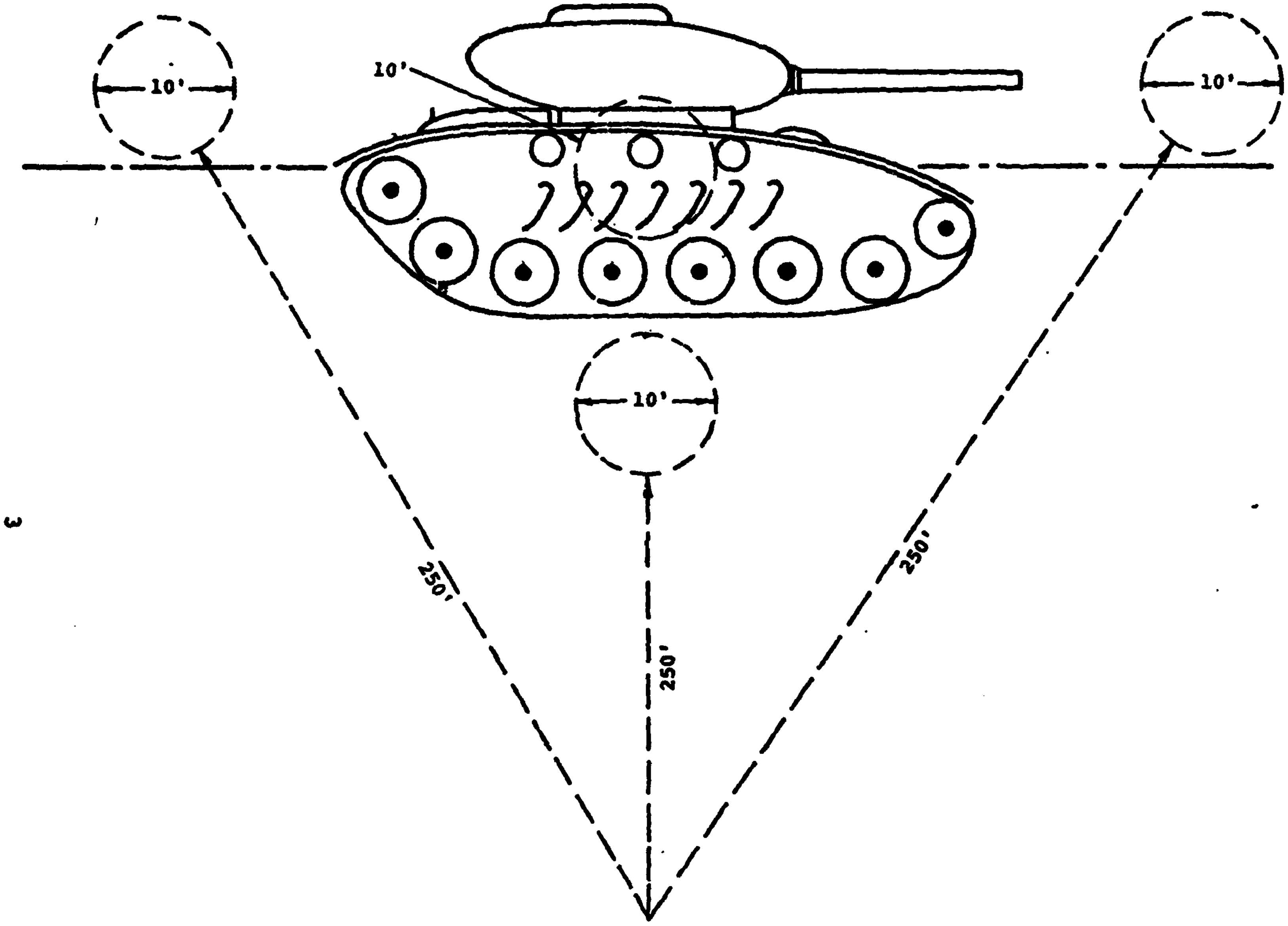


FIG 2

Vehicle	1	2
Start Time	____	____
Grey Card	____	____
1	____	____
2	____	____
3	____	____
4	____	____
Background		
Right	____	____
Center	____	____
Left	____	____
Grey Card	____	____
Stop Time	____	____

Background Description ______________________________

____

____

Date ________________________

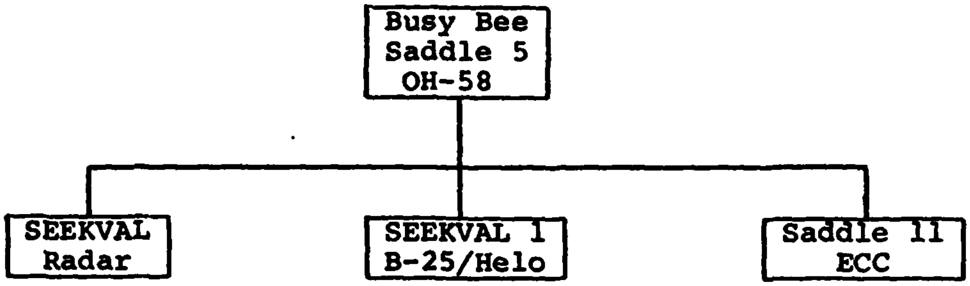
Target Type ____________________

Figure 3

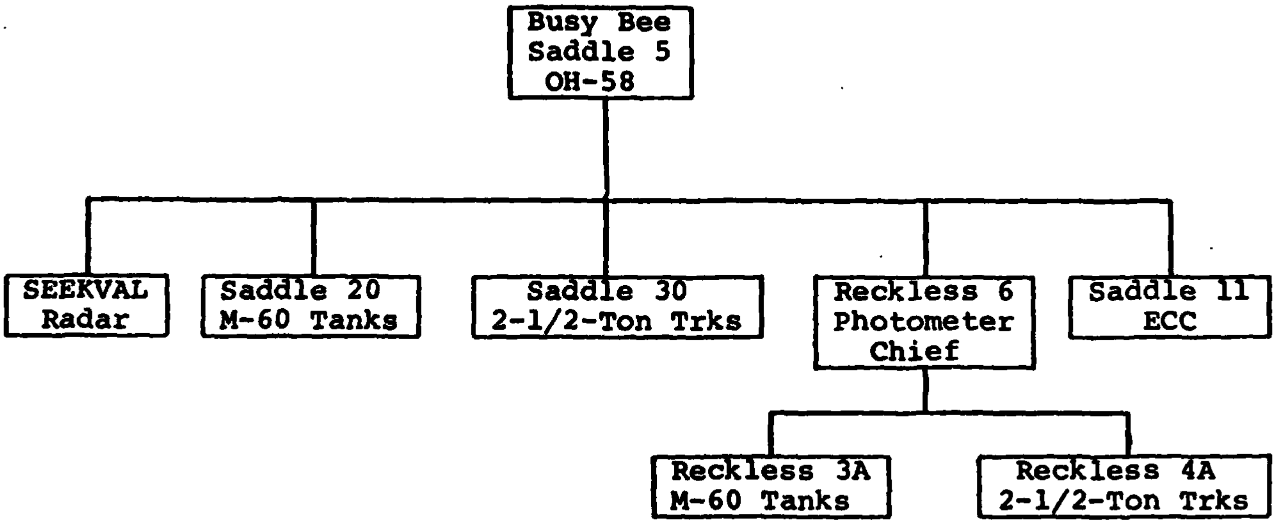
Data Collection Sheet

Radio Net Description

1. UHF. 373.4 MHz.



2. FM. 30.30 MHz.



Radar System Description

1. General. The USACDEC M-33 radar system used in the project is an I-band gunfire-control radar. It is the successor to the older SCR-584 system and has been superseded by the NIKE Ajax/Hercules equipment. As used in this experiment, it had the following capabilities:

a. Automatic beacon tracking.

b. Optical acquisition and identification.

c. Automatic X-Y coordinate plotting providing map overlays of aircraft tracks in several, selectable scales.

d. Provision for automatic altitude recording (not used in the project).

The system only capable of line-of-sight operation which limited its usefulness to fixed-wing operations.

2. Specific. The system is contained in a single, air-transportable trailer which contains all major components, including provisions for UHF/FM/telephonic communications. The tracking antenna is mounted on the trailer roof and must be stowed prior to movement. The trailer dimensions are:

Length - 28'8"
Width - 8'0"
Height - 11'3"
Weight - 14,400 lbs

Overall power requirements are:

38kVA, 208V, 3-phase, 400-Hz, four-wire
20kVA, 208V, 3-phase, 60-Hz, four-wire

3. Ancillary Equipment

a. Vega Telesponder

(1) Provides a point source of energy to obtain a precise, clutter-free track of target aircraft.

(2) Has the capability to send telemetry data back to the radar. This capability was not used in the project due to time constraints on aircraft configuration.

b. Radar Altimeter AN/APN-184. This unit can provide actual aircraft altitude (AGL) to the Vega telesponder for transmission to the radar tracking unit. As mentioned above, this was not used in the project due to late receipt of information of its capabilities and time constraints on aircraft configuration.

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4. TITLE (and Subtitle) IMAGERY COLLECTION		5. TYPE OF REPORT & PERIOD COVERED FINAL REPORT
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) WILLIAM W. MONK, LCDR, USN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS SEEKVAL JOINT TEST FORCE 1111 19th Street Arlington, VA, 22209		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PROJECT IC1
11. CONTROLLING OFFICE NAME AND ADDRESS OSD Washington, D. C.,20301 DDR&E		12. REPORT DATE March 1974
		13. NUMBER OF PAGES 107
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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SEEKVAL
TARGET ACQUISITION SIMULATION
FIXED WING MOTION PICTURES
ROTARY WING MOTION PICTURES
INFRARED LINE SCANNERS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report contains descriptions of the hardware,procedures, and instrumentation utilized to define the technical, mechanical, logistical, and administrative problems involved in the collection of 70mm motion picture and infrared imagery from fixed and rotary wing platforms.

Except for minor deficiencies, the equipment and procedures

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BLOCK 19
MITCHELL FC-65 CAMERA
AN/AAS-27
TODD-AO 70mm LENS
TYLER CAMERA MOUNT

BLOCK 20
used in fixed- and rotary-wing 70mm motion picture photography was satisfactory for use in future SEEKVAL projects.

The infrared sensor used was found to have unsatisfactory resolution for program requirements due to mounting deficiencies and lack of stabilization.

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